

**The Distribution of Landings of
British Columbia Salmon in
Relation to Size of the Commercial
Fishing Fleet, 1967-1981.
VI. Summary**

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SALMON IN RELATION TO SIZE OF THE COMMERCIAL FISHING
FLEET, 1967-1981. VI. SUMMARY

by

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ABSTRACT

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The distribution of landings of Pacific salmon in relation to the size of the commercial fishing fleet was investigated on an annual basis during 1967-1981. An average of 1932 gillnetters accounted for 90% of the total landings in any year. Fifty-five percent of the vessels participating in the gillnet fishery landed less than 6 metric tonnes of salmon annually. The top 50% of the vessels participating in the gillnet fishery accounted for 82% of the total annual landings. An average of 343 purse seiners accounted for 90% of the landings, and 52% of the seiners landed less than 45 metric tonnes of salmon annually. The top 50% of the seiners accounted for 77% of the total annual landings. An average of 1504 trollers accounted for 90% of the total annual landings of Pacific salmon. About 72% of all vessels participating in the troll fishery for Pacific salmon landed less than 6 metric tonnes of salmon annually. The top 50% of the vessels that landed troll-caught salmon accounted for 91% of the total annual landings.

Key words: British Columbia, catch, exploitation, gillnet, salmon seine, troll

RÉSUMÉ

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On a étudié sur une base annuelle, entre 1967 et 1981, la distribution des débarquements de saumon du Pacifique en fonction de la taille de la flottille de pêche commerciale. En moyenne, 1932 bateaux de pêche aux filets maillants réalisaient chaque année 90% de tous les débarquements. Cinquante-cinq pour cent des bateaux qui ont participé à la pêche aux filets maillants ont débarqué moins de 6 tonnes métriques de saumon par année. Les bateaux de pêche aux filets maillants se classant dans la moitié supérieure pour les prises ont fourni 82% du total des débarquements annuels. Une moyenne de 343 bateaux de pêche à la senne coulissante ont enregistré 90% des débarquements, et 52% des senneurs ont débarqué moins de 45 tonnes de saumon par année. Les senneurs se classant dans la moitié supérieure pour les prises ont ramené 77% du total des débarquements annuels. Une moyenne de 1,504 bateaux de pêche à la traîne ont réalisé 90% du total des débarquements annuels de saumon du Pacifique. Environ 72% de tous les bateaux s'adonnant à la pêche à la traîne du saumon du Pacifique ont débarqué moins de 6 tonnes métriques de saumon par année. Les bateaux de pêche à la traîne se classant dans la moitié supérieure pour les prises ont enregistré 91% du total des débarquements annuels.

Mots-clés: Colombie-Britannique, prises, exploitation, filets maillants, senne à saumon, traîne

INTRODUCTION

The British Columbia commercial fishing fleet for salmon is currently too large, given the amount of salmon to be harvested and the efficiency of the fleet to do so. A commission on Pacific fisheries policy suggested that the salmon fleet be reduced to half of its present capacity over a 10-year period (Pearse 1982). This reduction in fleet capacity was suggested to be accomplished by a buy-back program. In an evaluation of a buy-back program, a committee was established to recommend in part the number of vessels that should be present in the fishery after the buy-back program is completed. The recommendation for the salmon fleet was for 400 seiners, 1467 trollers, and 2208 gillnet plus gillnet/troll combination vessels (Cruikshank et al. 1982). This would represent a 25% decrease in the number of seiners (from 532 to 400), 12% for trollers (from 1667 to 1467), and 12% from gillnet plus gillnet/troll combination vessels (from 2508 to 2208). However, it is uncertain what the degree of redistribution of the landings would be if the suggested number of vessels were removed from the fleet.

Incomes are distributed non-uniformly among fishermen (Sinclair 1978). Landings of salmon may also be distributed non-uniformly among different vessels participating in the salmon fishery. The present report details the distribution of landings of the five species of Pacific salmon combined in relation to the size of the commercial fishing fleet and indicates the degree of redistribution of the landings that may be expected when decisions on fleet size are made.

An analysis was conducted in order to determine the distribution of landings in relation to the number of commercial fishing vessels for all species (pink, chum, sockeye, chinook, and coho salmon) combined on a weight basis. This analysis was conducted for each of the major gear components in the British Columbia salmon fishery (gillnet, seine, and troll). When the distribution of catch of Pacific salmon in relation to the size of the commercial fleet is known, decisions can be made on the level to which the fleet could be reduced. The present report deals with the distribution of landings of Pacific salmon during 1967-1981 in relation to the number of commercial fishing vessels in British Columbia.

MATERIALS AND METHODS

The information upon which the distribution of landings in relation to the size of the commercial fishing fleet is determined is derived from sales-slips. Wong (1983) has described the procedure used in recording and editing the information contained on the sales-slip. Summarized briefly, sales-slips are generated when the catch is delivered for processing or sold, and information on the commercial fishing vessel (CFV) license number, gear, area, period, and weight or numbers of species caught is recorded.



The analysis in the present study depended upon compiling the annual landings by species for each commercial fishing vessel in the three major gear classifications: purse seiner, gillnetter, and troller. This should be confidential information, so that, as outlined by Wong (1983), original commercial fishing vessel license numbers are converted to different codes by a standard method each year, so that it is not possible to relate catches to a specific vessel without authorization. The analysis for this report used solely the transformed license numbers.

The analysis of the sales-slips revealed that in some instances, there would be only 1 sales-slip for a particular license number in one of the three gear classes in a year. These were assumed to be errors in recording the license number, and were deleted in the subsequent description of the distribution of the catch. The distribution of catch was summarized in two ways, the first being by the number of vessels in a particular gear class, and the second by the percentage of vessels in a particular gear class. The number of vessels that landed salmon in a particular gear class was not constant during 1967-1981, so that both methods were used to describe the catch distribution.

Landings from combination vessels (gillnet and troll gear) were assigned to the gear used to catch the salmon sold at the time that the sales-slip was generated. Landings from a combination vessel would thus appear in both the troll and gillnet gear classes as appropriate.

The salmon sales-slip data tapes upon which the present analysis is based were derived from Wong (1983). The number of purse seiners recorded landing salmon in 1980 and 1981 was greater than the number of licensed vessels. It was assumed that errors were made in recording the gear of some commercial fishing vessel license numbers so that the maximum number of purse seiners in 1980 and 1981 was set at the number of licenses (532). For the analysis in this report, landings of salmon by purse seine vessels were arranged in descending order and landings from the 533rd vessel onwards were deleted. This removed those vessels with the smallest annual landings of salmon.

The top 400 vessels in terms of landings for a particular species were recorded annually for trollers and gillnetters during 1967-1981. The top 100 seiners were recorded annually during 1969-1981. When the top vessels were identified in a particular year, it was possible to examine how many were also in the top category in previous and subsequent years. For example, once the top 400 gillnetters had been identified in 1975, it was possible to examine how many of these same vessels were in the top 400 gillnetters in 1973 or 1981. This analysis was conducted in order to determine whether or not some vessels were successful on a continuing basis.

The analysis of distribution of landings in relation to the number of vessels in each fleet component first proceeded by determining annual landings for each species for each vessel in the three gear categories. The weights of salmon landed for each species were added together for each vessel. Vessels were then sorted in descending order based upon the size of the landings for each species. Once the total landings and the total number

of vessels that participated in the fishery were determined, it was then possible to calculate the proportion of the landings that was taken by different numbers of vessels and also different proportions of the fleet. It was also possible to calculate the number and percentage of vessels in different catch divisions based upon weight of salmon landed for each vessel.

RESULTS

GILLNET COMPONENT

The landings of salmon by gillnetters have ranged from 12 thousand metric tonnes in 1975 to 37 thousand metric tonnes in 1973 (Table 1). The gillnet share of the total landings of salmon has declined relative to the other gears when landings are considered on a coast-wide basis. Prior to 1970 gillnetters accounted for at least 40% of the coast-wide landings, but their share of the total landings declined to about 27% in 1980 and 24% in 1981.

The distribution of total landings of salmon in relation to the number of vessels participating in the gillnet fishery was examined on an annual basis during 1967-1981 (Appendix A, Tables A1-A15). This 15-year distribution of the landings in relation to the number of vessels in the fishery is summarized in Figure 1. An average of 1932 vessels accounted for 90% of the total landings in any year. The largest gillnet landings of salmon were recorded in 1973, and in that year 1888 vessels accounted for 90% of the total landings. In 1975, 1850 vessels accounted for 90% of the landings. The top 1521 vessels accounted for an average of 80% of the total landings in any year (Table 2). The increase in landings in moving from 80 to 90% of the total landings was accompanied by an increase in the number of vessels by 27%. In examining the number of vessels that account for 100% of the landings as compared with 90%, the number increased 66% from 1932 to 3212 vessels.

The frequency of total landings per vessel was also investigated on an annual basis. An average of 55% of the vessels participating in the gillnet fishery for salmon landed less than 6 metric tonnes of salmon annually during 1967-1981 (Table 3). About 5% of the vessels landed more than 21 metric tonnes of salmon annually. The poorest 33% of the vessels participating in the gillnet fishery land less than 3 metric tonnes of salmon each in most years. The top 50% of the vessels participating in the gillnet fishery during 1967-1981 accounted for an average of 82% of the total annual landings (Table 4). Recall that 80% of the total gillnet landings of salmon was accounted for by an average of 1521 vessels.

The repeatability of success in landing salmon was examined by identifying the top 400 gillnetters in each year during 1967-1981 and tallying how many of these 400 were in the top 400 in all other years. The results are illustrated in Table 5. With an average of 3212 vessels in the fishery and under the assumption of a random distribution of the top 400 vessels in all

years except the one in which they were the top 400 vessels, one would expect an average of $(400/3212) \times 400 = 50$ vessels to appear by chance. If 64 or more appear, there is a significant statistical association ($\chi^2 = 3.84$, $P < 0.05$), which indicates that vessels successful in one year were also successful in previous and successive years. For example, if one examines the top 400 vessels in 1974, there was a significant number of these vessels that were also in the top 400 vessels during 1967-1981 (Table 5). This analysis indicates that successful salmon gillnet vessels tend to be successful on a continuing basis.

SEINE COMPONENT

The landings of salmon by purse seiners have ranged from 7 thousand metric tonnes in 1969 to 41 thousand metric tonnes in 1981 (Table 1). The proportion of the total landings accounted for by purse seiners has increased from less than 40% before 1970 to 54% in 1981.

The distribution of total landings of salmon in relation to the number of purse seiners was examined on an annual basis during 1967-1981 (Appendix B, Tables B1-B15). The distribution of the landings in relation to the number of purse seiners participating in the fishery is summarized in Figure 2. On an average basis between 1967 and 1981, about 343 purse seiners accounted for 90% of the total landings in any year. However, in 1969, when 7 thousand metric tonnes were landed, 282 vessels accounted for 90% of the total landings, and in 1981, when 41 thousand metric tonnes of salmon were landed by purse seiners, 423 vessels accounted for 90% of the total (Table 6). The top 279 vessels accounted for an average of 80% of the total landings in any year. In moving from 80 to 90% of the total landings of salmon, the number of vessels increased from 279 to 343. This increase in catch was accounted for by a 23% increase in the number of vessels. In examining the number of vessels that account for 100% of the landings, the number was an average of 520, an increase of 52% over the number of vessels accounting for 90% of the landings.

The frequency of total landings per vessel was also investigated on an annual basis. About 52% of the purse seiners participating in the salmon fishery landed less than 45 metric tonnes annually (Table 7). An average of about 13% of the vessels landed in excess of 90 metric tonnes of salmon annually. The top 50% of the vessels participating in the fishery during 1967-1981 accounted for an average of 77% of the total annual landings (Table 4). Recall that 80% of the total purse seine landings of salmon was previously noted to be accounted for by the top 279 purse seiners.

The annual repeatability of success in landing salmon in the purse seine fishery was examined by identifying the top 100 seiners in each year during 1969-1981 and tallying how many of these 100 were in the top 100 in all other years (Table 8). Using an average of 520 vessels in the fishery, one would expect, under the assumption of a random distribution of the top 100 vessels in all years except the one in which they were the top 100 vessels, that an average of $(100/520) \times 100 = 19$ vessels to appear by chance. If 28 or more vessels appear, this indicates that vessels successful in one year (the

diagonal of 100s in Table 9) were also successful in the year for which 28 or more vessels are counted ($\chi^2 = 3.84$, $P < 0.05$). For example, the top 100 seiners for salmon in 1974 were also more successful for sockeye salmon during 1971-1977 than one would expect by chance (Table 9). There is some evidence to indicate that successful salmon purse seine vessels tend to be successful for a range of years.

TROLL COMPONENT

Landings of troll-caught salmon have ranged between 10.4 thousand metric tonnes in 1975 and 18.3 thousand metric tonnes in 1971 (Table 1). In 1981 trollers accounted for 22% of the total commercial landings of salmon.

The distribution of total landings of salmon in relation to the number of vessels that used troll gear to land salmon was examined on an annual basis during 1967-1981 (Appendix C, Tables C1-C15). The distribution of landings of salmon in relation to the number of vessels using troll gear that participated in the fishery is summarized in Fig. 3. On an average basis between 1967 and 1981, about 1504 trollers accounted for 90% of the landings in any year (Table 9). Trollers had the greatest landing of salmon in any year during 1967-1981 in 1971, and in that year, 1567 vessels accounted for 90% of the total landings. The best 1500 trollers accounted for 90% of the landings in 1981. On an average basis between 1967 and 1981, the top 1132 vessels accounted for 80% of the landings in any year. In increasing from 80 to 90% of the total troll-caught landings of salmon, the average number of vessels that accounted for the catch increased from 1132 to 1504, an increase of 33%. An average of 3177 vessels accounted for 100% of troll-caught salmon, an increase of 111% over the number of vessels accounting for 90% of the landings.

The frequency of total landings per vessel was also investigated on an annual basis during 1967-1981. An average of 87 vessels landed in excess of 18 metric tonnes of salmon annually (Table 10). Of the vessels that used troll gear to land salmon, about 72% of these vessels landed less than 6 metric tonnes of troll-caught salmon annually. The top 50% of the vessels that landed troll-caught salmon during 1967-1981 accounted for an average of 91% of the total annual landings (Table 4).

The annual repeatability of success in landing salmon in the troll fishery was examined by identifying the top 400 vessels in each year during 1967-1981, and tallying how many of these 400 were in the top 400 in all other years (Table 11). Using an average of 3177 vessels in the fishery, one would expect, under the assumption of a random distribution of the top 400 vessels in all years except the one in which they were the top 400 vessels, that an average of $(400 \times 400 / 3177) = 50$ vessels to appear by chance. If 64 or more vessels appear, this indicates that the vessels successful in one year (the diagonal of 400s in Table 11) were also successful in the year in which 64 or more vessels were counted ($\chi^2 = 3.84$, $P < 0.05$). For example, the top 400 trollers in 1977 were also more successful for salmon during 1967 to 1981

(except 1968) than one would expect by chance alone (Table 11). Most comparisons shown in Table 11 are statistically significant. This analysis indicates that successful troll vessels for salmon tend to be successful for a number of years.

DISCUSSION

The number of vessels accounting for 90% of the harvest of British Columbia salmon under a similar management policy as was instituted during 1967-1981 was found to be about 1932 gillnet vessels, 343 purse seine vessels, and 1504 trollers. Reducing the size of the commercial fleet to the previously noted levels would not significantly reduce the overall landings of salmon nor the exploitation rates on the species. With less competition among vessels of each gear class under a reduced fleet size, the exploitation rate of an average vessel could increase to the extent that overall exploitation rates on salmon stocks could increase. Exploitation rates must necessarily continue to be regulated by restrictions on fishing time and locations.

The number of vessels of each gear class that the present analysis indicates would be sufficient to harvest British Columbia salmon is less than the recommendations of a British Columbia fleet rationalization committee of 2208 gillnetters, 400 seiners, and 1467 trollers (Cruickshank et al. 1982). The present analysis suggests that the number of seiners could be reduced by 36% (from 532 to 343), gillnetters and combination gillnet/troll vessels by 23% (from 2508 to 1932), and trollers by 10% (from 1667 to 1504) and the landings of salmon would not be significantly reduced. It is assumed that the least effective vessels would be removed from the fishery.

Reduction of fleet size to the levels suggested by the fleet rationalization committee (Cruickshank et al. 1982) were projected to result in rapid rises in income to the vessels remaining in the commercial fleet. The present analysis for salmon suggests that if the least efficient vessels are removed from the fleet, mean landings of salmon per vessel will not increase and thus mean gross income per vessel remaining in the fleet will not increase, as long as total catches do not increase and prices remain stable.

The present report outlines the number of vessels necessary to harvest British Columbia salmon in the commercial fleet if current management practices are continued and gear distributions of catch are maintained. It does not consider the social implications of reduction of fleet size and these should be considered in the establishment of targets for a reduced size of the commercial salmon fleet in British Columbia.

ACKNOWLEDGMENTS

Mr. Fred Wong made available the data upon which the distribution of landings of salmon in relation to fleet size was determined.

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Table 1. Commercial landings (metric tonnes) of Pacific salmon in British Columbia, 1967-1981.

Year	Gillnet	Seine	Troll
1967	23530	21922	14964
1968	33529	31117	15411
1969	17777	6981	11103
1970	30867	25549	13747
1971	22105	19698	18257
1972	28532	33054	12889
1973	36712	33345	13928
1974	24334	22038	14502
1975	12002	12144	10408
1976	17749	24970	12599
1977	22024	24503	16098
1978	19057	34328	14591
1979	13392	24711	19512
1980	14042	24789	12745
1981	18087	40984	16811

Table 2. Number of gillnetters accounting for varying percentages of the total gillnet landings of salmon in British Columbia, 1967-1981.

Percent of total landings	Year															
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
10	100	99	111	107	110	90	105	99	70	98	90	99	85	74	88	950
20	237	233	259	240	252	213	233	230	169	229	211	225	197	175	202	220
30	400	393	436	394	417	358	380	384	291	383	352	370	328	297	334	368
40	587	578	639	572	601	524	546	556	441	563	515	534	475	439	481	537
50	803	796	868	777	807	716	732	750	625	765	708	720	641	605	646	731
60	1055	1048	1132	1015	1041	936	942	968	844	991	931	929	829	795	829	952
70	1346	1343	1441	1297	1314	1199	1187	1217	109	1247	1196	1168	1043	1018	1036	1211
80	1695	1702	1814	1645	1643	1528	1488	1510	1430	1547	1516	1451	1289	1285	1276	1521
90	2155	2170	2310	2135	2085	1982	1888	1982	1850	1929	1919	1813	1597	1656	1582	1932
100	3851	3848	3734	3899	3845	3717	3120	3113	2010	2845	2779	2694	2276	2950	2508	3212

Table 3. Frequencies (and percentage) of vessels landing salmon in British Columbia by gillnets, 1967-1981.

Catch interval (metric tonnes)	Year						
	1967	1968	1969	1970	1971	1972	1973
0-3	1486(38.6)	1260(32.7)	1442(38.6)	1392(35.7)	1519(39.5)	1361(36.6)	687(22.0)
3-6	817(21.2)	614(16.7)	1104(29.6)	647(16.6)	703(18.3)	574(15.4)	414(13.3)
6-9	724(18.8)	646(16.7)	711(19.0)	520(13.3)	639(16.6)	502(13.5)	353(11.3)
9-12	406(10.5)	496(12.9)	304(8.1)	439(11.3)	494(12.8)	387(10.4)	374(12.0)
12-15	230(6.0)	288(7.5)	116(3.1)	319(8.2)	304(7.9)	324(8.7)	300(9.6)
15-18	100(2.6)	224(5.8)	41(1.1)	223(5.7)	117(3.0)	211(5.7)	292(9.4)
18-21	53(1.3)	129(3.4)	11(0.3)	167(4.3)	43(1.1)	157(4.2)	228(7.3)
21-24	17(0.4)	72(1.9)	1(0.0)	102(2.6)	17(0.4)	80(2.2)	177(5.7)
24-27	10(0.3)	40(1.0)	2(0.1)	49(1.3)	3(0.1)	53(1.4)	114(3.7)
27-30	3(0.1)	18(0.5)	0(0.0)	22(0.6)	3(0.1)	24(0.6)	96(3.1)
30+	5(0.1)	34(0.9)	2(0.1)	19(0.5)	3(0.1)	44(1.2)	85(2.7)
Total	3851	3848	3734	3899	3845	3717	3120
							870(27.9)
							510(16.4)
							521(16.7)
							516(16.8)
							343(11.0)
							184(5.9)
							90(2.9)
							45(1.4)
							20(0.6)
							4(0.1)
							10(0.3)
							3113

Catch interval (metric tonnes)	Year						
	1975	1976	1977	1978	1979	1980	1981
0-3	1489(49.5)	725(25.5)	482(17.3)	627(23.3)	540(23.7)	1323(44.8)	672(26.8)
3-6	956(31.8)	812(28.5)	741(26.7)	637(23.6)	829(36.4)	702(23.8)	450(17.9)
6-9	306(10.2)	772(27.1)	621(22.3)	655(24.3)	564(24.8)	503(17.1)	547(21.8)
9-12	154(5.1)	314(11.0)	405(14.6)	413(15.3)	236(3.3)	240(8.1)	452(18.0)
12-15	66(2.2)	142(5.0)	229(8.2)	223(8.3)	76	105(3.6)	226(9.0)
15-18	22(0.7)	50(1.8)	154(5.5)	87(3.2)	22(1.0)	47(1.6)	103(4.1)
18-21	10(0.3)	19(0.7)	93(3.3)	39(1.4)	8(0.4)	20(0.7)	34(1.4)
21-24	4(0.1)	9(0.3)	28(1.0)	8(0.3)	1(0.0)	4(0.1)	15(0.6)
24-27	2(0.1)	0(0.0)	11(0.4)	5(0.2)	0(0.0)	3(0.1)	4(0.2)
27-30	1(0.0)	2(0.1)	7(0.3)	0(0.0)	0(0.0)	3(0.1)	4(0.2)
30+	0(0.0)	0(0.0)	8(0.3)	0(0.0)	0(0.0)	1(0.0)	2(0.1)
Total	3010	2845	2779	2694	2276	2950	2508
							1058(33.0)
							703(21.9)
							572(17.8)
							375(11.7)
							219(6.8)
							125(3.9)
							73(2.3)
							39(1.2)
							13(0.4)
							13(0.4)
							14(0.4)
							3212

Table 4. Percentage of the total landings of Pacific salmon that the top 50% of the vessels participating in the fishery account for in each gear type.

Year	Gillnet	Seine	Troll
1967	85	83	94
1968	85	87	95
1969	82	80	92
1970	87	89	92
1971	86	90	93
1972	88	89	92
1973	82	76	91
1974	82	72	91
1975	83	78	91
1976	77	70	89
1977	76	68	88
1978	77	70	88
1979	73	68	88
1980	85	70	89
1981	88	67	90
Mean	82	77	91

Table 5. A measure of the repeatability of success of landing Pacific salmon by gillnetters. The top 400 gillnetters in terms of weight of salmon landings were identified each year (diagonal in table). The number of times that these 400 vessels were in the top 400 in previous and subsequent years is recorded by column. For example, of the top 400 gillnetters in 1977, 53 of those 400 were also in the top 400 in 1967 and 119 in the top 400 in 1981. Sixty-four or more vessels is indicative of a significant statistical association.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1967	400	184	148	114	115	106	89	72	70	59	53	50	34	38	41
1968	184	400	150	150	124	113	101	86	61	59	53	61	41	43	43
1969	148	150	400	165	177	160	147	115	93	88	70	88	56	52	63
1970	114	150	165	400	167	162	154	108	73	60	85	68	56	56	51
1971	115	124	177	167	400	193	168	131	103	89	110	97	71	75	62
1972	106	113	160	162	193	400	207	171	108	110	103	107	77	85	71
1973	89	101	147	154	168	207	400	184	125	114	136	133	109	106	88
1974	72	86	115	108	131	171	184	400	124	152	127	137	99	101	92
1975	70	61	93	73	103	108	125	125	400	138	121	95	89	108	80
1976	59	59	88	60	89	110	114	152	138	400	87	136	85	102	108
1977	53	53	70	85	110	103	136	127	121	87	400	155	201	182	119
1978	50	61	88	68	97	107	133	137	95	136	155	400	150	164	150
1979	34	41	56	56	71	77	109	99	89	85	201	150	400	181	173
1980	38	43	52	56	75	85	106	101	108	102	182	164	181	400	185
1981	41	43	63	51	62	71	88	92	80	108	119	150	173	185	400

Table 6. Number of purse seiners accounting for varying percentages of the total seine landings of salmon in British Columbia, 1967-1981.

Percent of total landings	Year														
	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981 1967-81
10	18	18	14	17	17	15	20	22	12	21	20	23	24	22	27
20	40	41	32	40	38	34	44	50	31	48	46	53	54	51	60
30	64	65	52	67	61	57	72	81	54	80	78	86	87	84	97
40	91	92	76	97	88	84	102	116	84	115	115	121	125	121	138
50	122	122	103	131	117	113	136	156	119	155	157	161	168	164	182
60	158	155	134	168	151	147	173	199	159	198	204	205	215	213	232
70	198	191	172	209	188	186	215	245	206	247	257	256	268	268	287
80	246	231	217	257	230	232	262	297	262	303	316	315	329	334	349
90	303	282	275	315	282	288	318	360	333	368	384	388	401	412	423
100	536	526	438	613	565	561	488	506	504	500	490	506	517	532	532

Table 7. Frequencies (and percentage) of vessels landing salmon in British Columbia by purse seines, 1967-1981.

Catch interval (metric tonnes)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-15	165(30.8)	172(32.7)	240(54.8)	220(35.9)	222(39.3)	187(33.3)	89(18.2)	74(14.6)
15-30	47(8.8)	31(5.9)	138(31.5)	48(7.8)	44(7.8)	34(6.1)	25(5.1)	61(12.1)
30-45	100(18.7)	36(6.8)	49(11.2)	67(10.9)	80(14.2)	41(7.3)	26(5.3)	128(25.3)
45-60	75(14.0)	37(7.0)	10(2.3)	82(13.4)	98(17.3)	43(7.7)	60(12.3)	135(26.7)
60-75	60(11.2)	57(10.8)	1(0.2)	81(13.2)	47(8.3)	63(11.2)	80(16.4)	63(12.5)
75-90	36(6.7)	62(11.8)	0(0.0)	48(7.8)	40(7.1)	43(7.7)	58(11.9)	29(5.7)
90-105	28(5.2)	49(9.3)	0(0.0)	31(5.1)	17(3.0)	36(6.4)	50(10.2)	10(2.0)
105-120	16(3.0)	38(7.2)	0(0.0)	16(2.6)	13(2.3)	33(5.9)	40(8.2)	3(0.6)
120-135	6(1.1)	27(5.1)	0(0.0)	8(1.3)	3(0.5)	26(4.6)	23(4.7)	1(0.2)
135-150	3(0.6)	7(1.3)	0(0.0)	5(0.8)	0(0.0)	15(2.7)	20(4.1)	2(0.4)
150+	0(0.0)	10(1.9)	0(0.0)	7(1.1)	1(0.2)	40(7.1)	17(3.5)	0(0.0)
Total	536	526	438	613	565	561	488	506

Catch interval (metric tonnes)	Year							
	1975	1976	1977	1978	1979	1980	1981	1987-81
0-15	176(34.7)	54(10.8)	17(3.5)	16(3.2)	20(3.9)	29(5.5)	8(1.5)	113(21.7)
15-30	185(36.7)	45(9.0)	65(13.3)	38(7.5)	90(17.4)	116(21.8)	14(2.6)	65(12.5)
30-45	88(17.5)	133(26.6)	152(31.0)	86(17.0)	163(31.5)	153(20.3)	52(9.8)	90(17.3)
45-60	30(6.0)	111(22.2)	129(26.3)	98(19.4)	109(21.1)	108	103(19.4)	82(15.8)
60-75	11(2.2)	80(16.0)	62(12.7)	72(14.2)	70(13.5)	61(11.5)	101(19.0)	61(11.7)
75-90	7(1.4)	39(7.8)	22(4.5)	72(14.2)	46(8.9)	39(7.3)	89(16.7)	42(8.1)
90-105	5(1.0)	19(3.8)	25(5.1)	60(11.9)	11(2.1)	12(2.3)	70(13.2)	28(5.4)
105-120	0(0.0)	6(1.2)	7(1.4)	29(5.7)	2(0.4)	9(1.7)	44(8.3)	17(3.3)
120-135	0(0.0)	9(1.8)	5(1.0)	17(3.4)	5(1.0)	2(0.4)	23(4.3)	10(1.9)
135-150	2(0.4)	4(0.8)	5(1.0)	10(2.0)	1(0.2)	3(0.6)	18(3.4)	10(1.9)
150+	0(0.0)	0(0.0)	1(0.2)	8(1.6)	0(0.0)	0(0.0)	10(1.9)	6(1.2)
Total	504	500	490	506	517	532	532	420

Table 8. A measure of the repeatability of success of landing Pacific salmon by purse seiners. The top 100 seiners in terms of weight of salmon landings were identified each year (diagonal in table). The number of times that those 100 vessels were in the top 100 in previous and subsequent years is recorded by column. For example, of the top 100 seiners in 1975, 26 of those 100 were also in the top 100 in 1969 and 22 in vessels in 1981. Twenty-eight or more vessels is indicative of a significant statistical association.

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1969	100	32	60	37	41	32	26	20	15	17	16	15	10
1970	32	100	36	35	28	22	20	23	17	19	6	13	7
1971	60	36	100	49	50	37	27	22	18	20	16	20	11
1972	37	35	49	100	46	38	26	28	19	26	10	19	11
1973	41	28	50	46	100	45	39	27	20	18	16	16	19
1974	32	22	37	38	45	100	38	35	29	24	16	21	17
1975	26	20	27	26	39	38	100	36	39	25	25	20	22
1976	20	23	22	28	27	35	36	100	54	43	26	34	23
1977	15	17	18	19	20	29	39	54	100	46	35	38	28
1978	17	19	20	26	18	24	25	43	46	100	40	38	30
1979	16	6	16	10	16	16	25	26	35	40	100	44	53
1980	15	13	20	19	16	21	20	34	38	38	44	100	42
1981	10	7	11	11	19	17	22	23	28	30	53	42	100

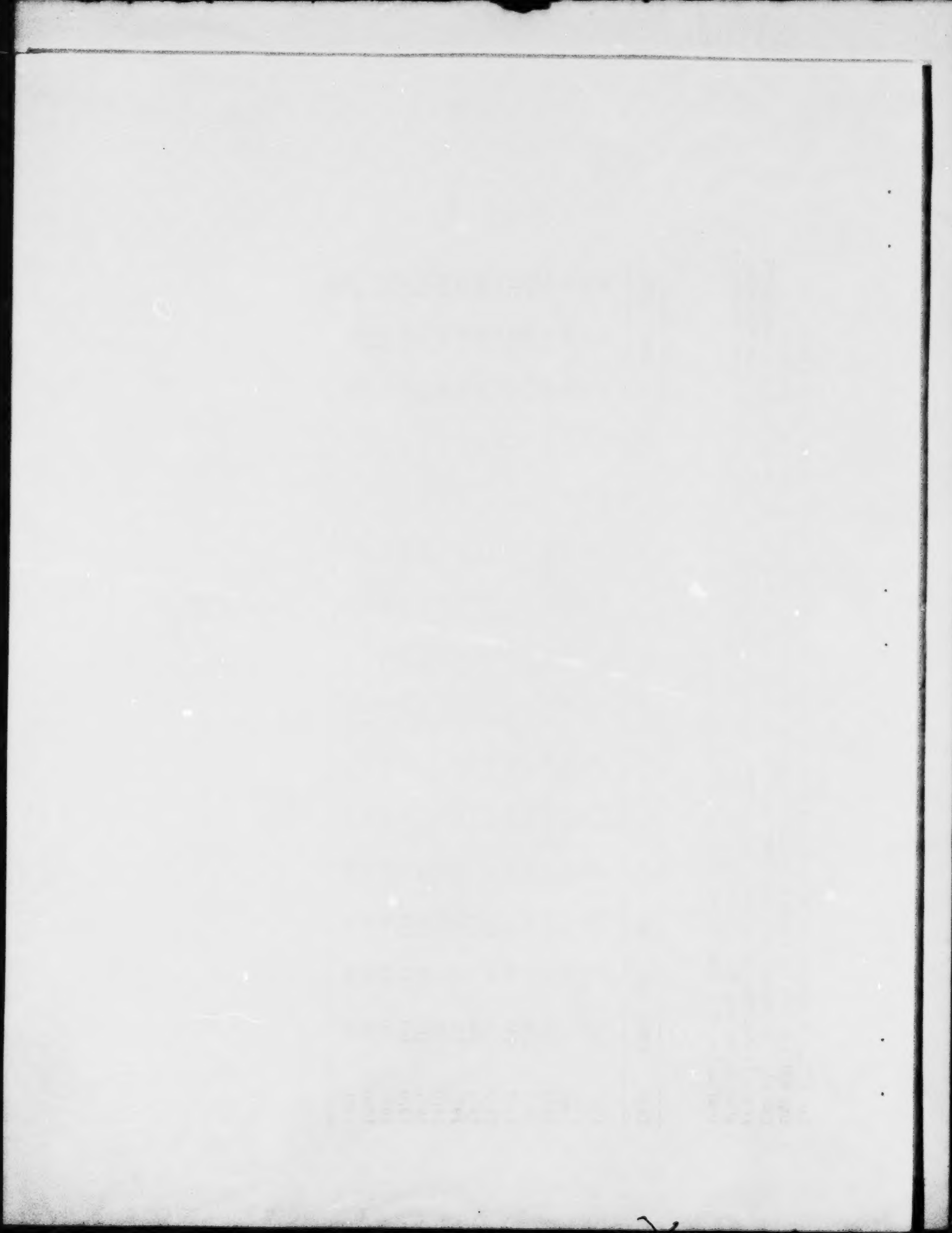
Table 10. Frequencies (and percentage) of vessels landing salmon in British Columbia by troll gear, 1967-1981.

Catch interval (metric tonnes)	Year							
	1967	1968	1969	1970	1971	1972	1973	1974
0-3	2341(61.8)	2395(72.1)	2036(61.3)	2067(57.4)	1923(53.4)	1961(57.2)	1487(51.0)	1340(48.4)
3-6	573(15.1)	372(11.2)	636(19.2)	718(19.9)	504(14.0)	641(18.7)	553(19.0)	465(16.8)
6-9	338(8.9)	197(5.9)	351(10.6)	393(10.9)	394(10.9)	420(12.3)	346(11.9)	381(13.7)
9-12	231(6.1)	94(2.8)	169(5.1)	217(6.0)	290(8.1)	214(6.2)	245(8.4)	244(8.8)
12-15	154(4.1)	68(2.0)	67(2.0)	90(2.5)	217(6.0)	101(2.9)	124(4.3)	145(5.2)
15-18	75(2.0)	64(1.9)	35(1.1)	62(1.7)	110(3.1)	49(1.4)	64(2.2)	90(3.2)
18-21	41(1.1)	46(1.4)	12(0.4)	26(0.7)	78(2.2)	20(0.6)	40(1.4)	50(1.8)
21-24	12(0.3)	32(1.0)	5(0.2)	16(0.4)	28(0.8)	12(0.4)	28(1.0)	29(1.0)
24-27	14(0.4)	19(0.6)	6(0.2)	8(0.2)	22(0.6)	3(0.1)	13(0.4)	12(0.4)
27-30	7(0.2)	24(0.7)	1(0.0)	5(0.1)	16(0.4)	1(0.0)	7(0.2)	6(0.2)
30+	5(0.1)	11(0.3)	1(0.0)	0(0.0)	20(0.6)	4(0.1)	7(0.2)	9(0.3)
Total	3791	3322	3319	3602	3602	3426	2914	2771

Catch interval (metric tonnes)	Year							
	1975	1976	1977	1978	1979	1980	1981	1967-81
0-3	1650(58.0)	1412(51.0)	1268(44.7)	1372(46.2)	1180(39.6)	1953(55.6)	1328(44.5)	1714(54.0)
3-6	553(19.4)	550(19.8)	524(18.5)	593(20.0)	478(16.0)	769(21.9)	513(17.2)	563(17.7)
6-9	325(11.4)	378(13.6)	396(14.0)	482(16.2)	438(14.7)	441(12.6)	438(14.7)	381(12.0)
9-12	172(6.0)	208(7.5)	288(10.2)	273(9.2)	350(11.7)	198(5.6)	272(9.1)	231(7.3)
12-15	80(2.8)	106(3.8)	137(4.8)	130(4.4)	229(7.7)	92(2.6)	199(6.7)	129(4.1)
15-18	35(1.2)	54(1.9)	96(3.4)	69(2.3)	138(4.6)	26(0.7)	110(3.7)	72(2.3)
18-21	16(0.6)	39(1.4)	59(2.1)	30(1.0)	76(2.5)	19(0.5)	62(2.1)	41(1.3)
21-24	10(0.4)	15(0.5)	30(1.1)	11(0.4)	39(1.3)	6(0.2)	35(1.2)	21(0.7)
24-27	3(0.1)	3(0.1)	19(0.7)	5(0.2)	22(0.7)	1(0.0)	7(0.2)	7(0.2)
27-30	0(0.0)	2(0.1)	9(0.3)	3(0.1)	10(0.3)	1(0.0)	7(0.2)	7(0.2)
30+	1(0.0)	4(0.1)	9(0.3)	3(0.1)	23(0.8)	0(0.0)	7(0.2)	7(0.2)
Total	2845	2771	2835	2971	2983	3510	2986	3177

Table 11. A measure of the repeatability of success of landing Pacific salmon by trollers. The top 400 trollers in terms of weight of salmon landings were identified each year (diagonal in table). The number of times that those 400 vessels were in the top 400 in previous and subsequent years is recorded by column. For example, of the top 400 trollers in 1975, 131 of those 400 were also in the top 400 trollers in 1967 and 162 in the top 400 in 1981. Sixty-four or more vessels is indicative of a significant statistical association.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1967	400														
1968	75	400													
1969	213	72	400												
1970	185	64	239	400											
1971	178	73	233	246	400										
1972	142	55	180	216	203	400									
1973	154	66	199	207	226	242	400								
1974	146	55	179	197	213	227	267	400							
1975	131	54	157	169	187	197	239	272	400						
1976	135	50	153	160	164	172	222	243	256	400					
1977	117	52	131	143	159	157	193	223	235	254	400				
1978	103	43	114	142	140	146	180	193	213	241	253	400			
1979	90	53	95	118	129	124	152	166	185	194	223	248	400		
1980	82	39	91	108	111	122	133	144	155	162	170	199	223	400	
1981	91	42	97	104	118	119	140	149	162	159	177	195	237	216	400



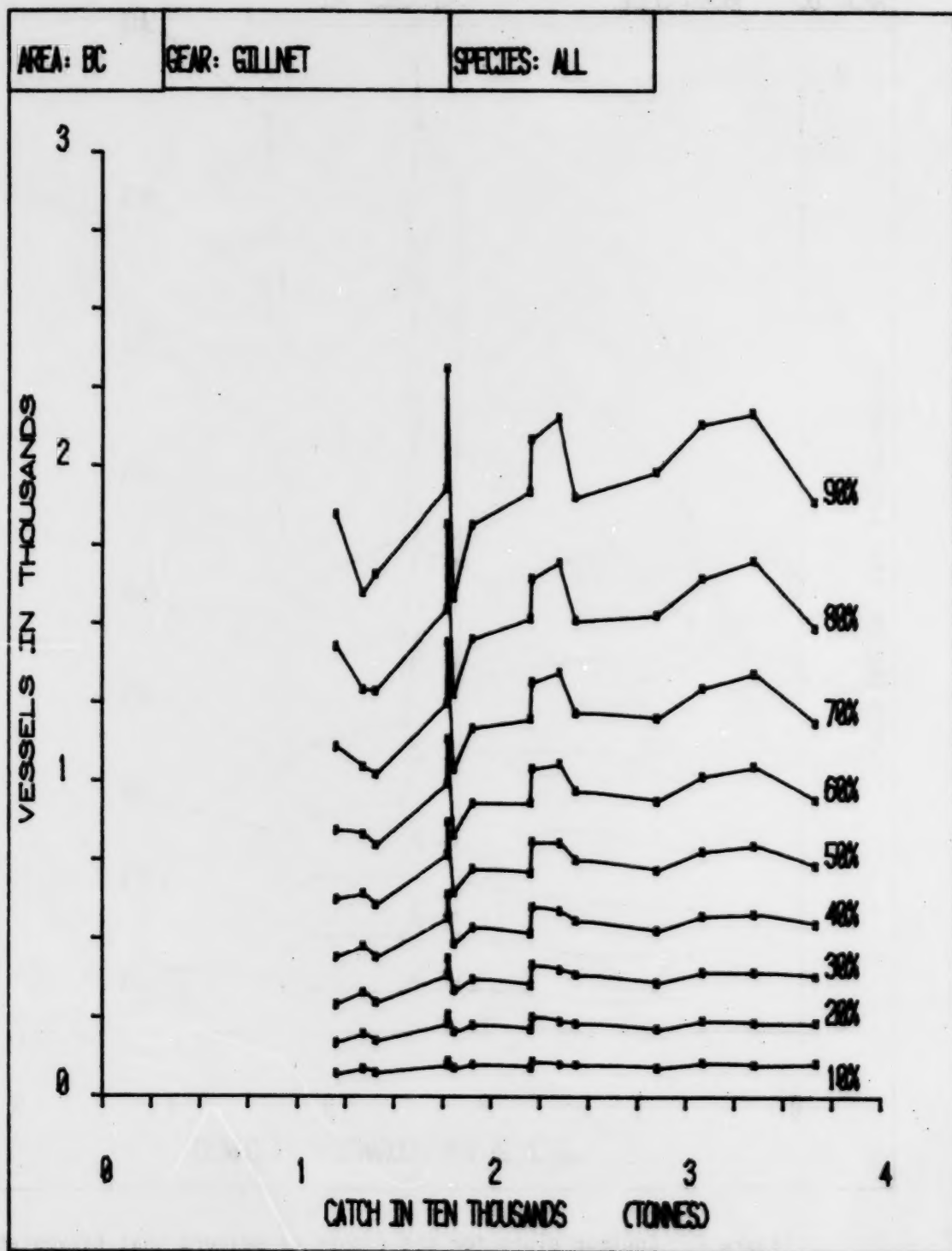


Figure 1. Contour plots for the annual number of gillnetters that harvested a fixed percentage of the total annual catch of Pacific salmon by gillnetters versus the size of the annual catch during 1967-1981.

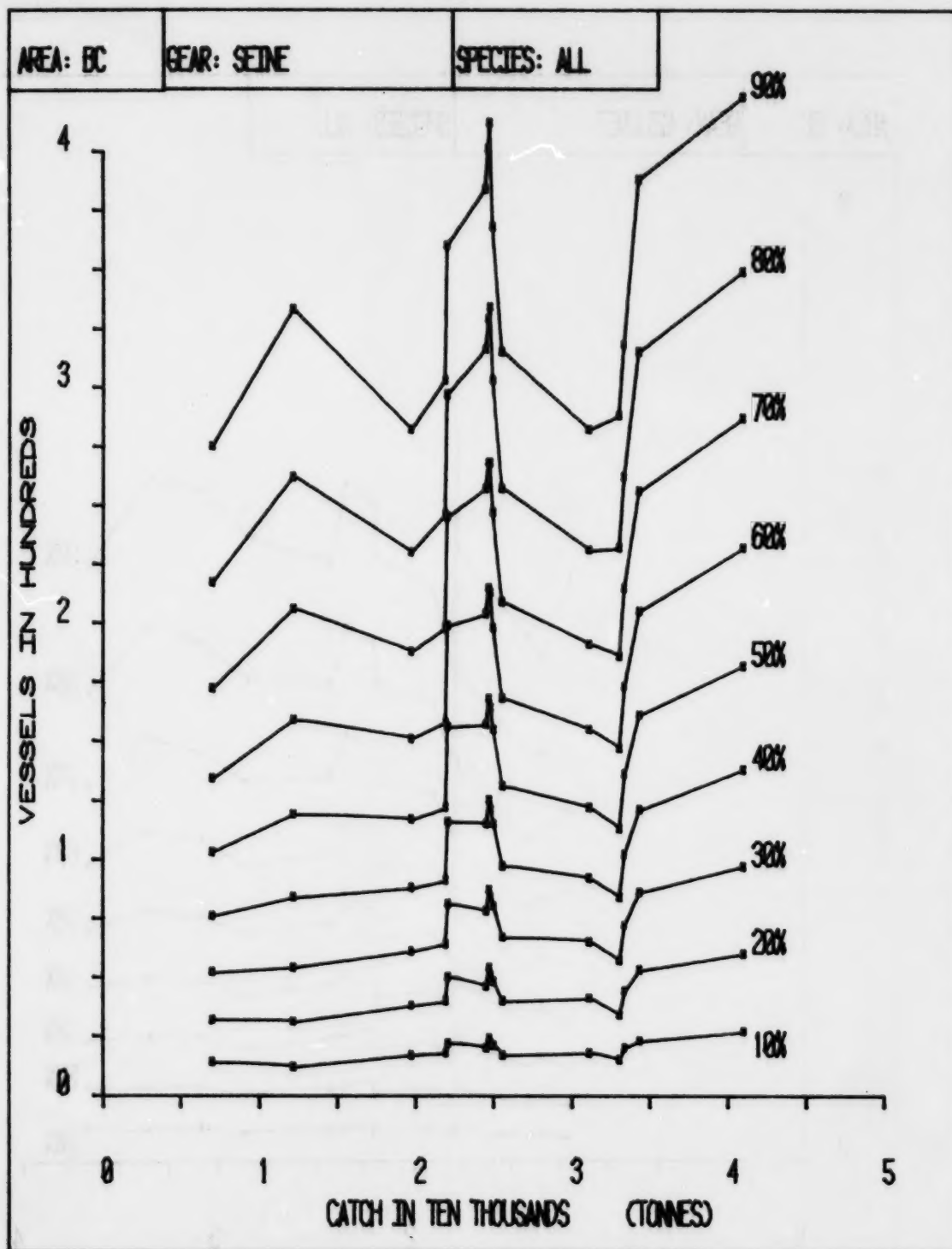


Figure 2. Contour plots for the number of seiners that harvested a fixed percentage of the total annual catch of Pacific salmon by seiners versus the size of the annual catch during 1967-1981.

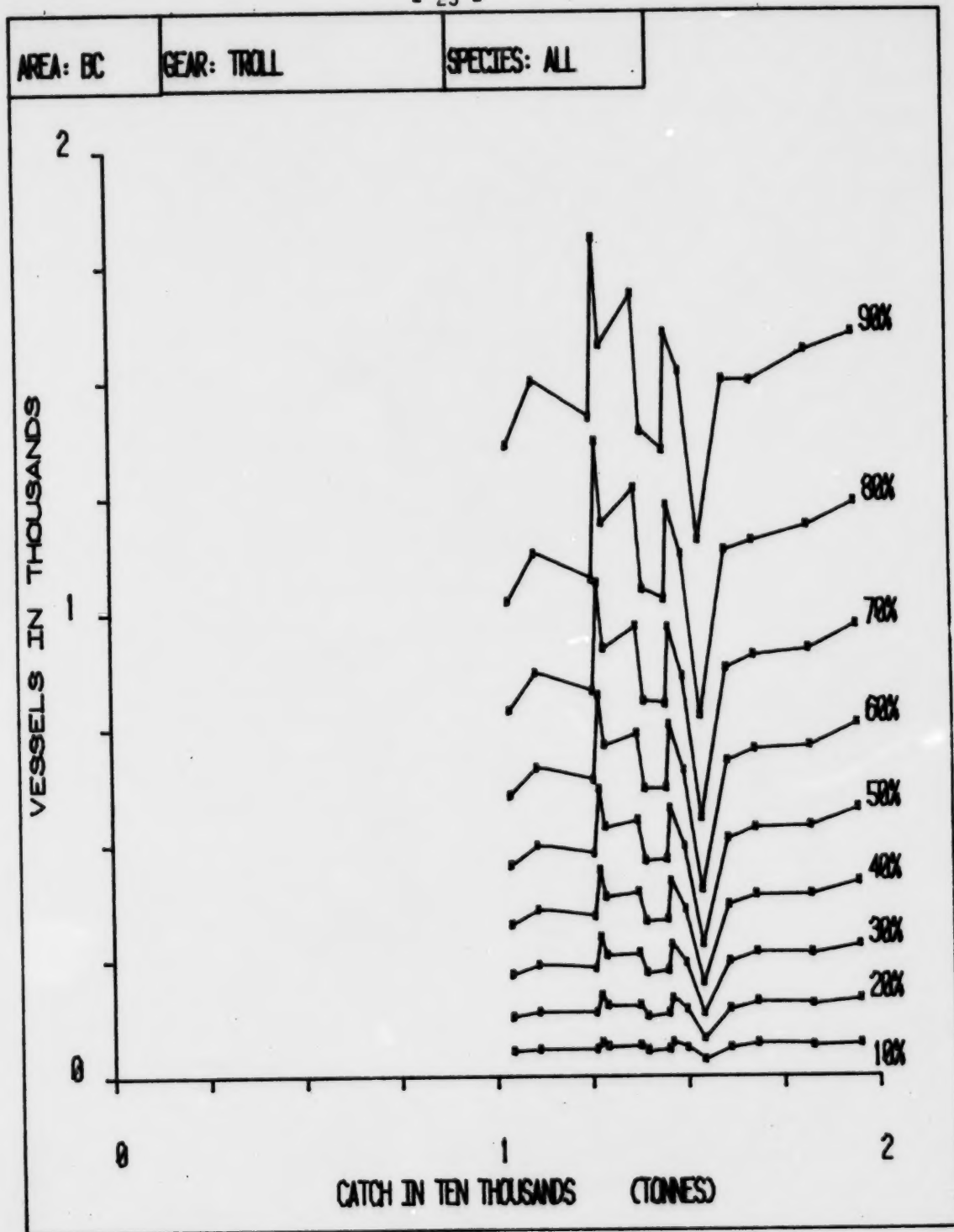


Figure 3. Contour plots for the number of trollers that harvested a fixed percentage of the total annual catch of Pacific salmon by trollers versus the size of the annual catch during 1967-1981.

APPENDIX A

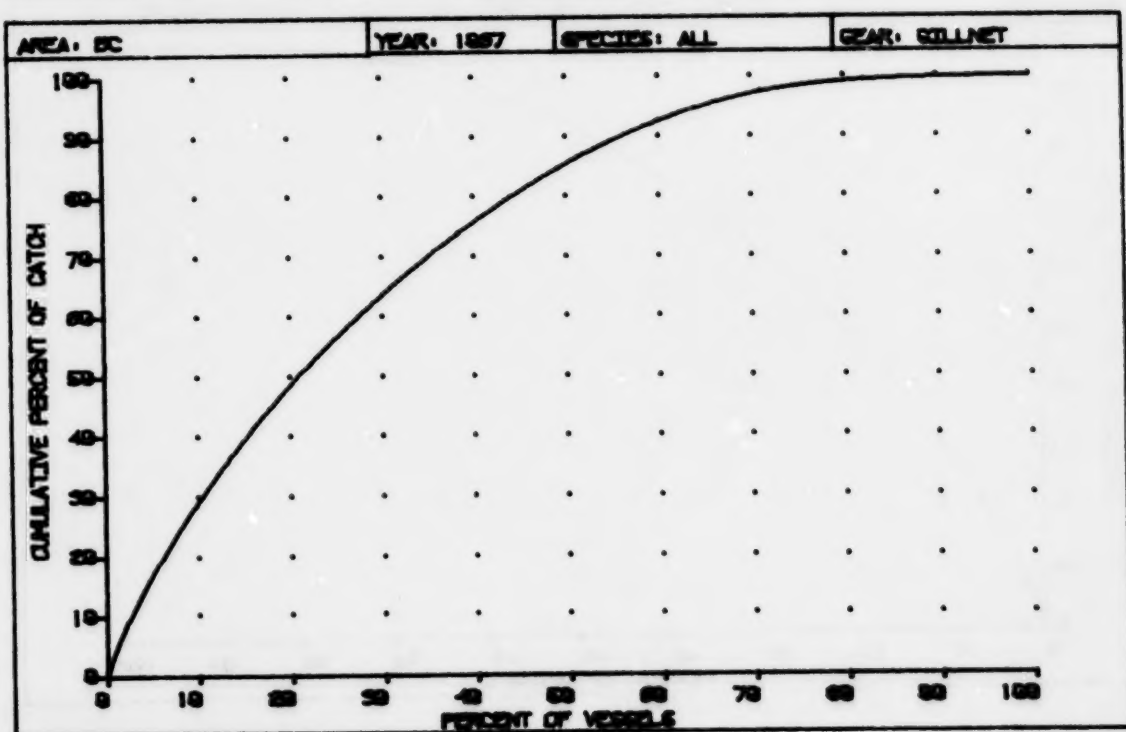
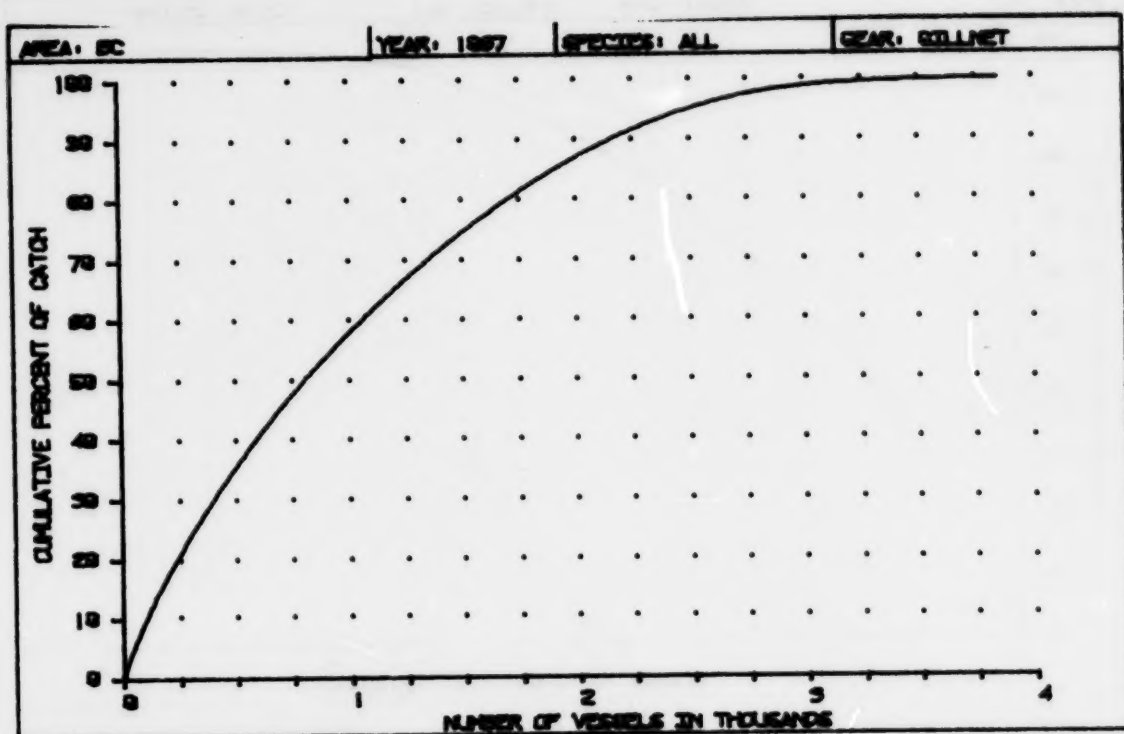


Figure A1. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1967.

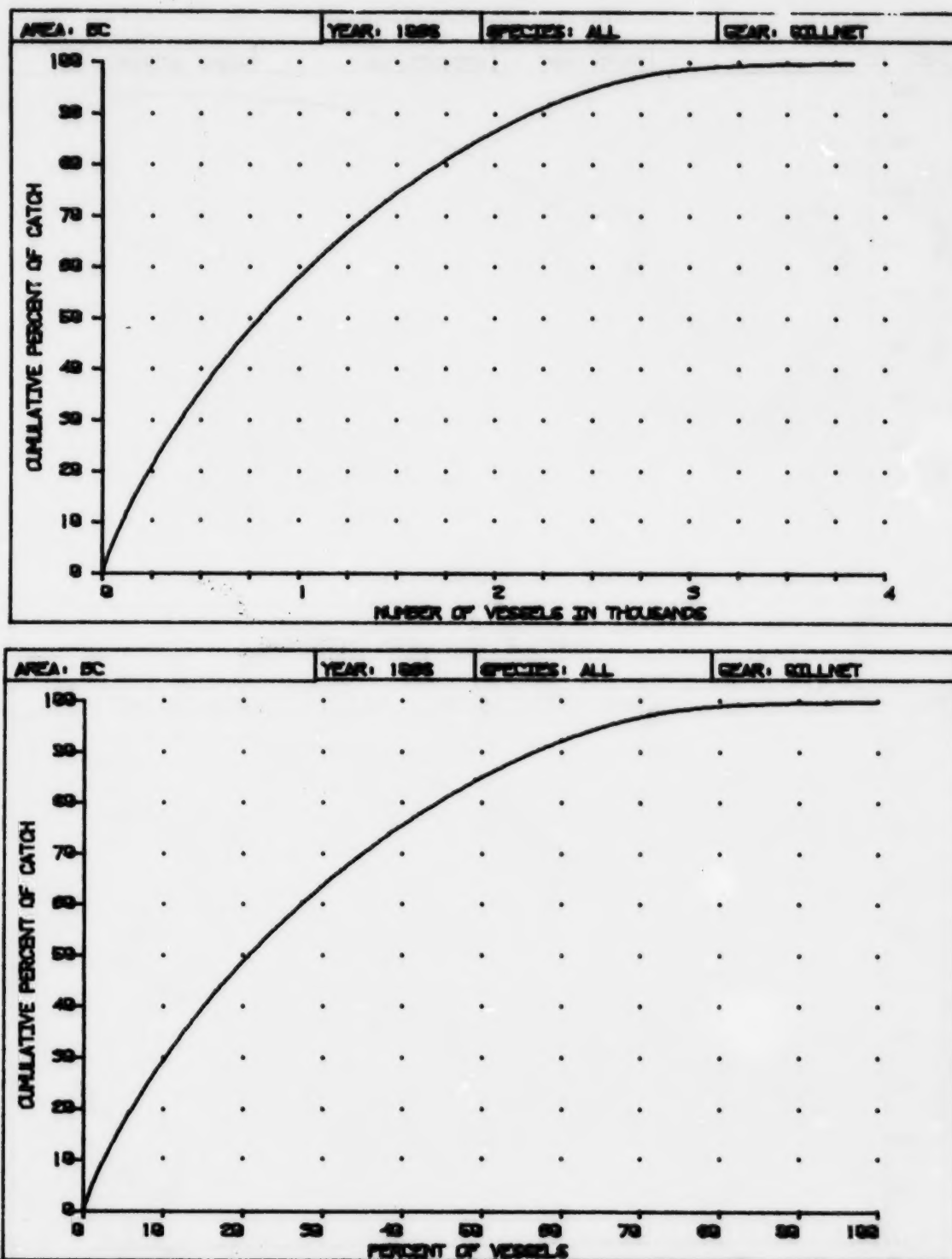


Figure A2. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1968.

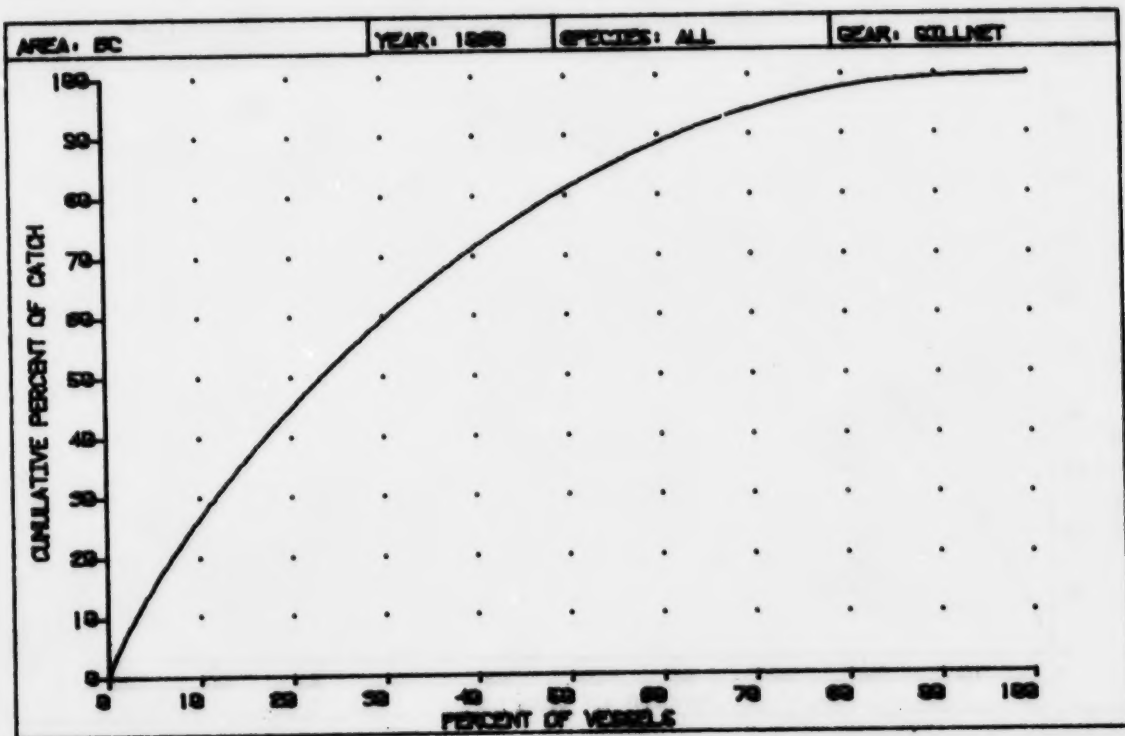
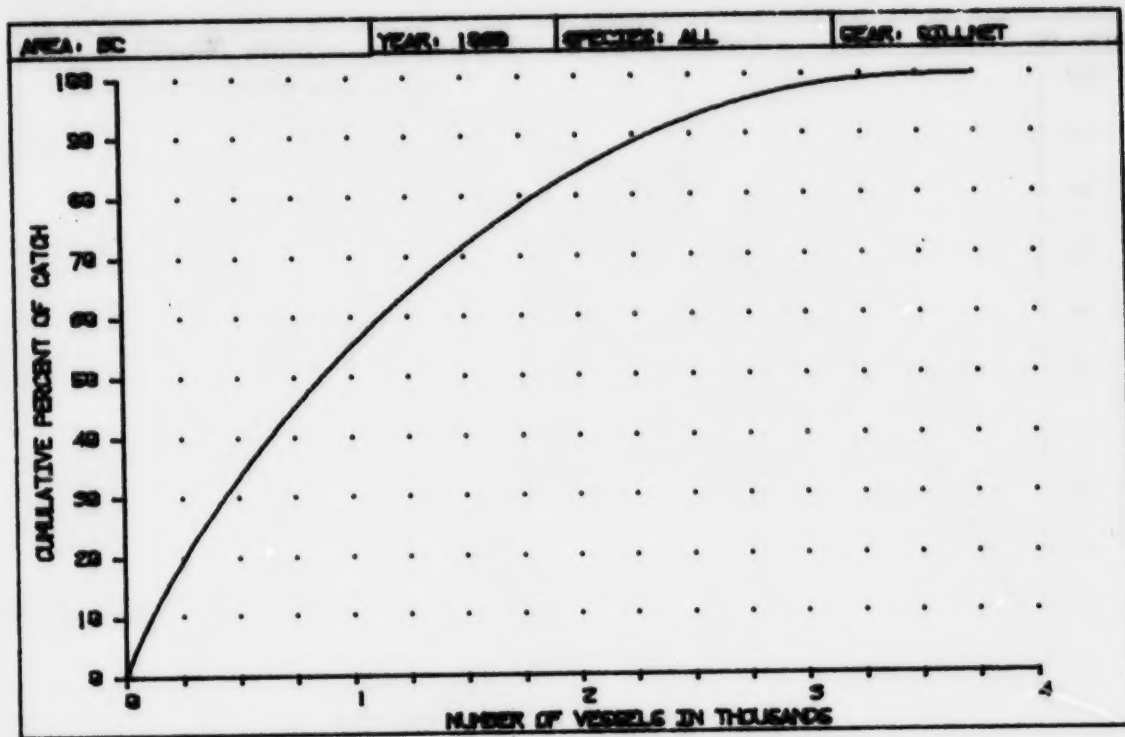


Figure A3. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1969.

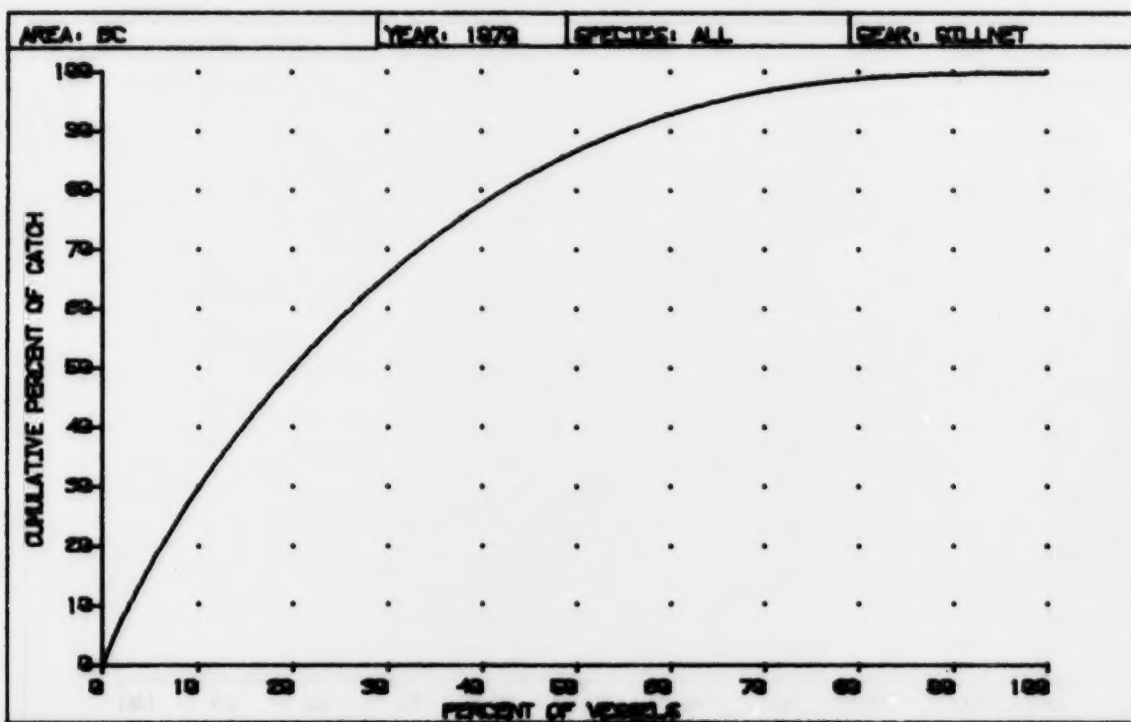
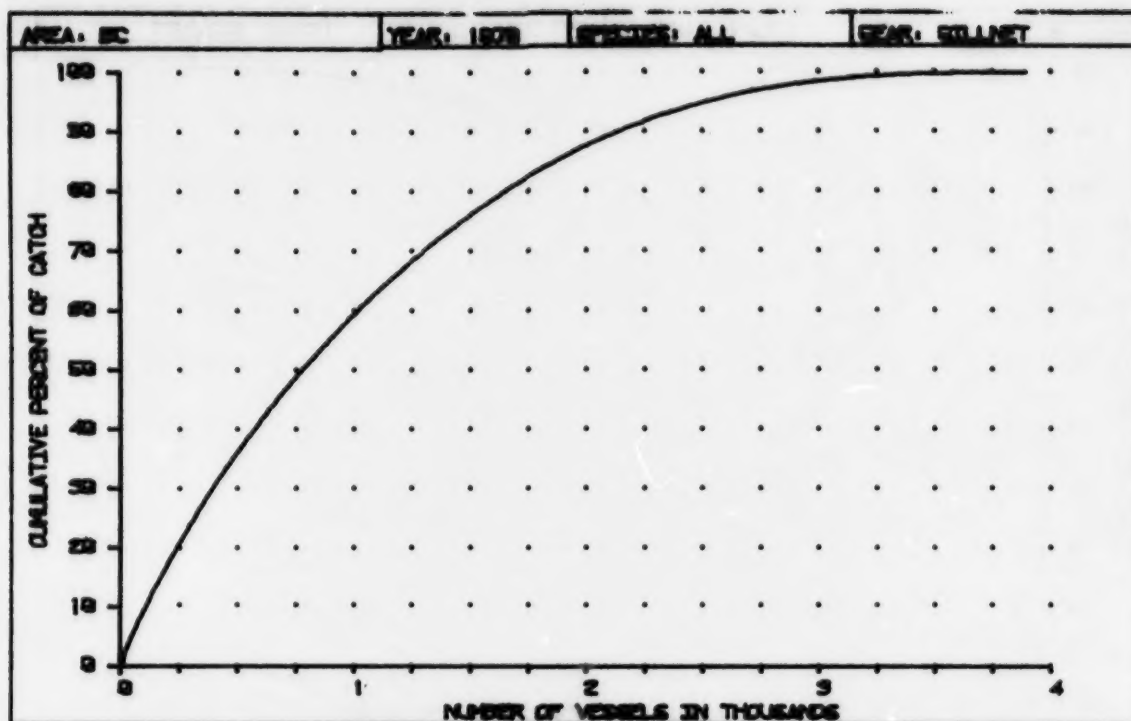


Figure A4. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1970.

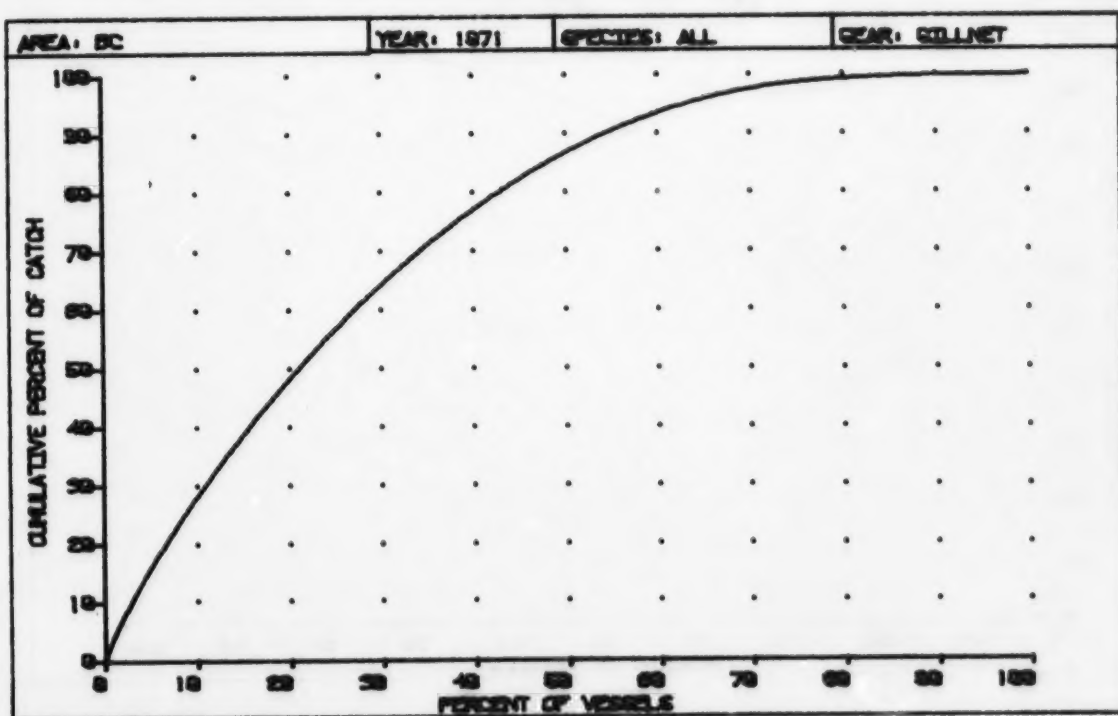
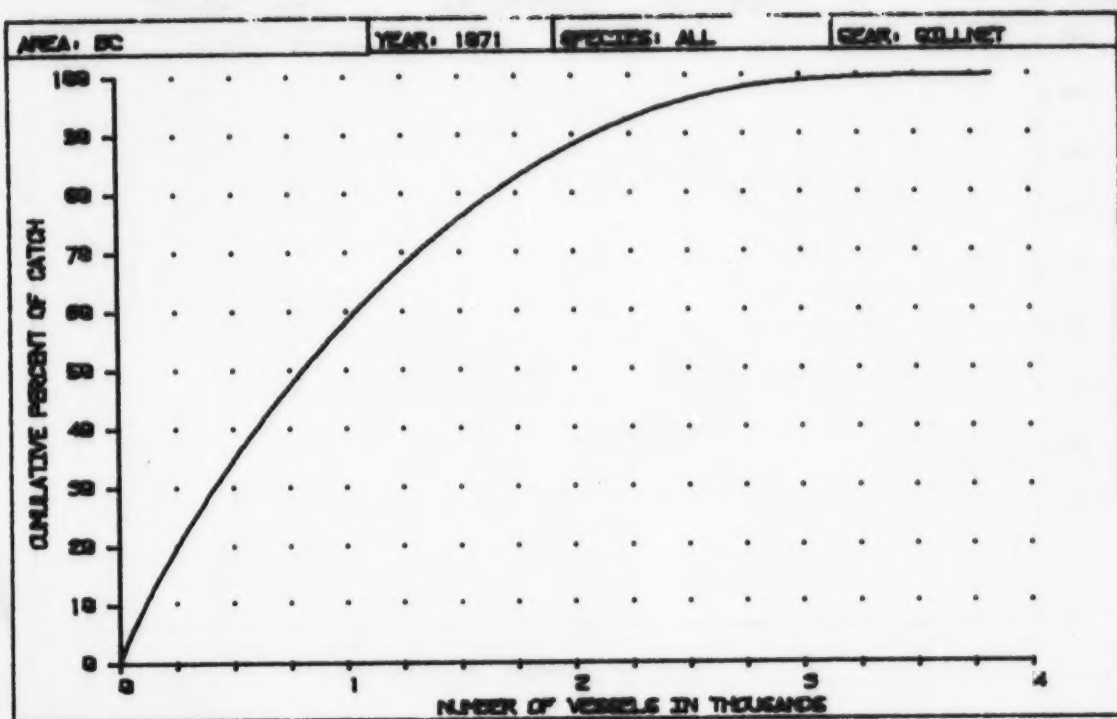


Figure A5. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1971.

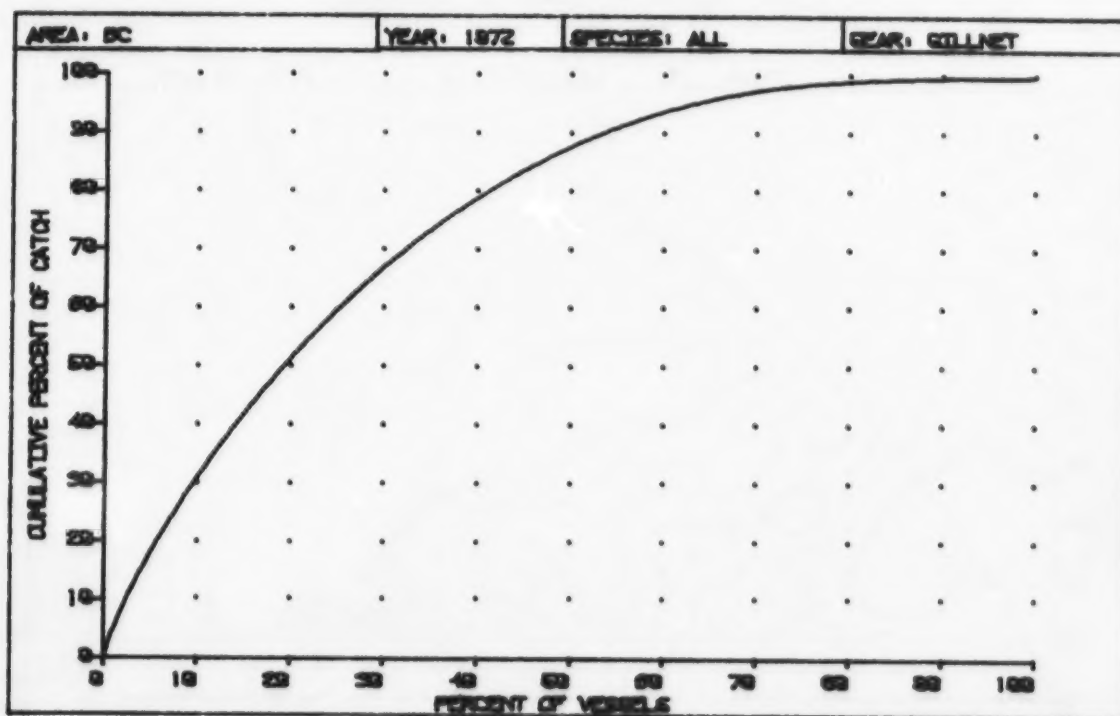
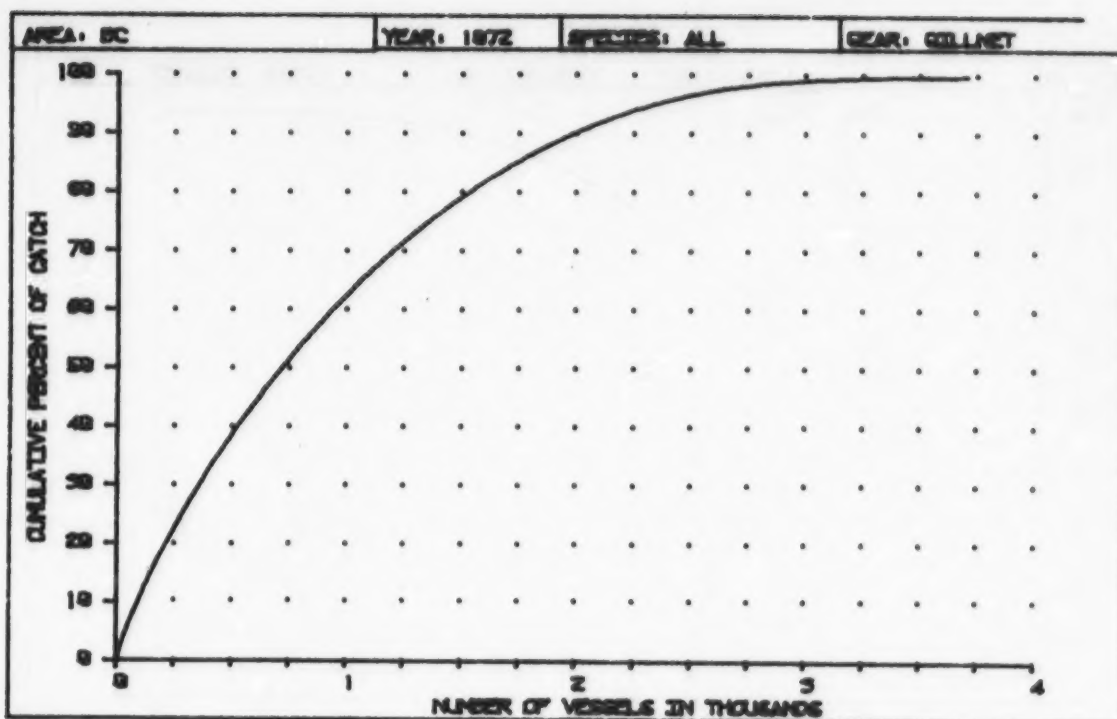


Figure A6. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1972.

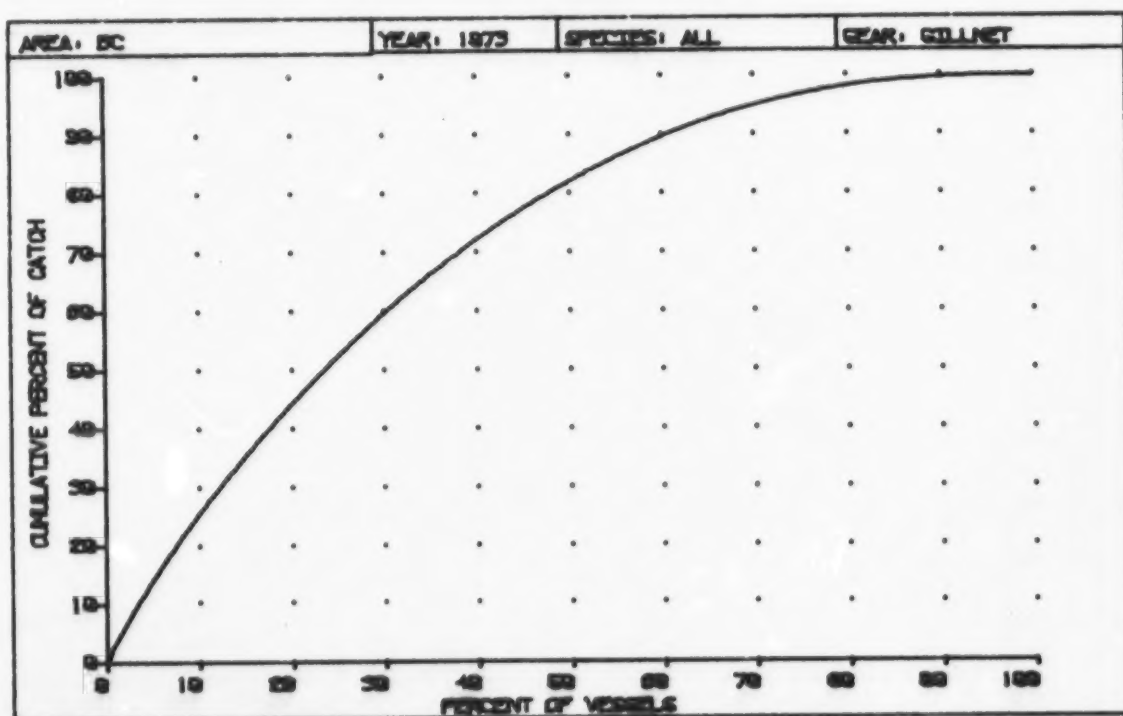
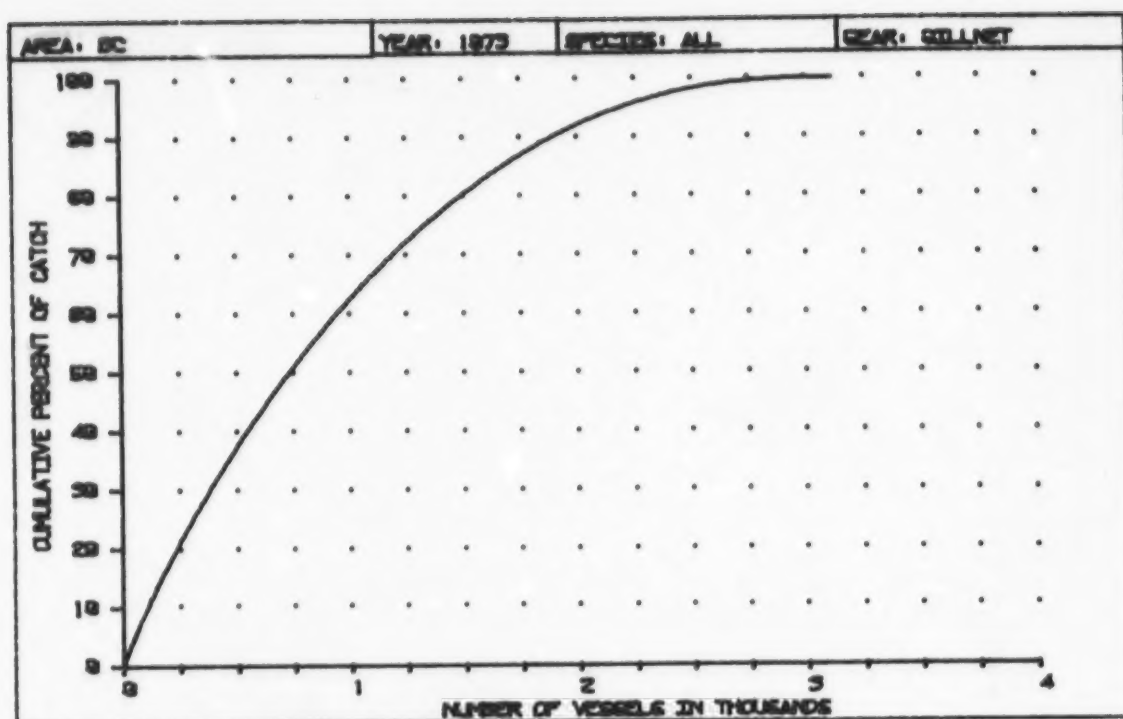


Figure A7. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1973.

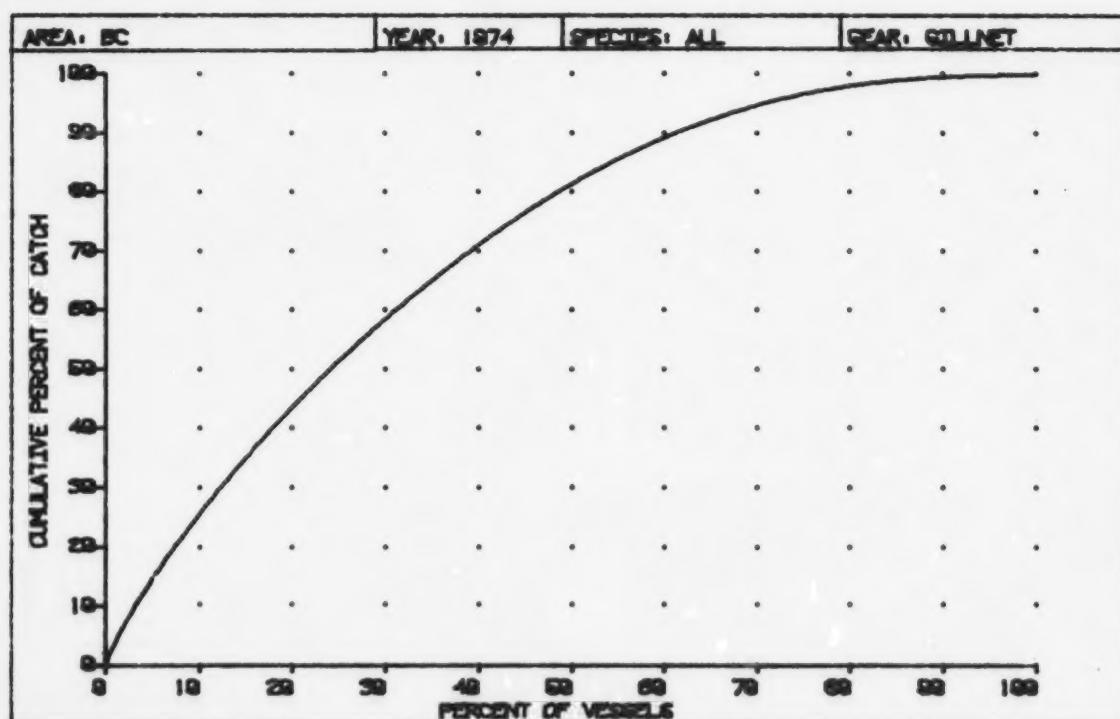
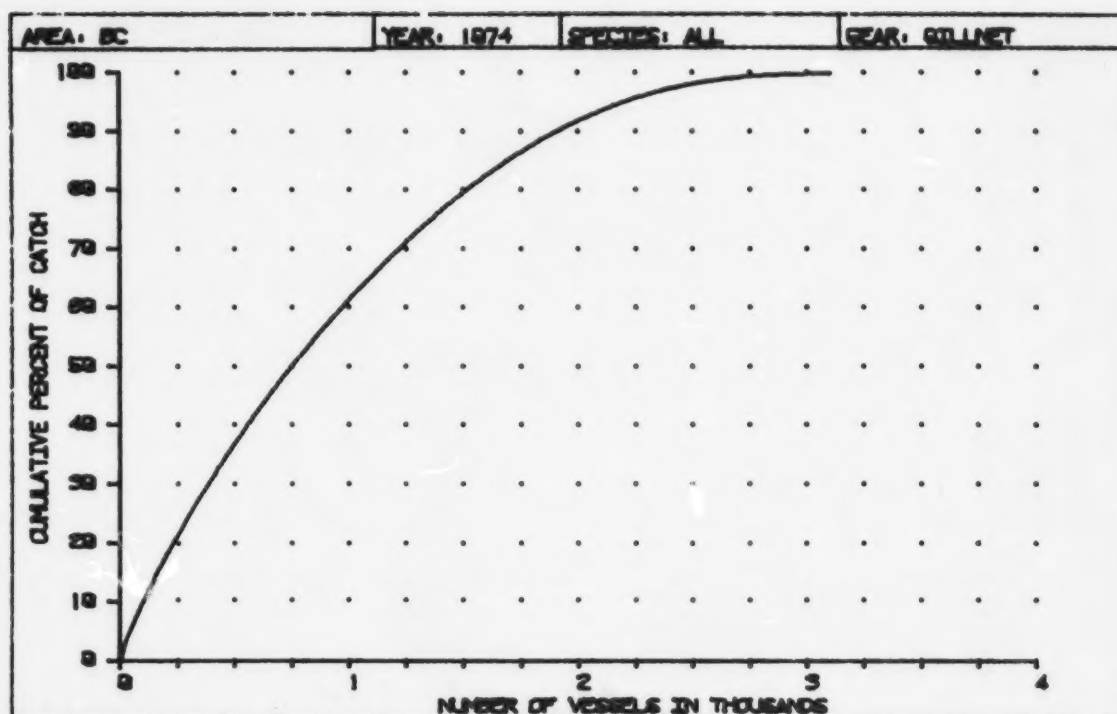


Figure A8. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1974.

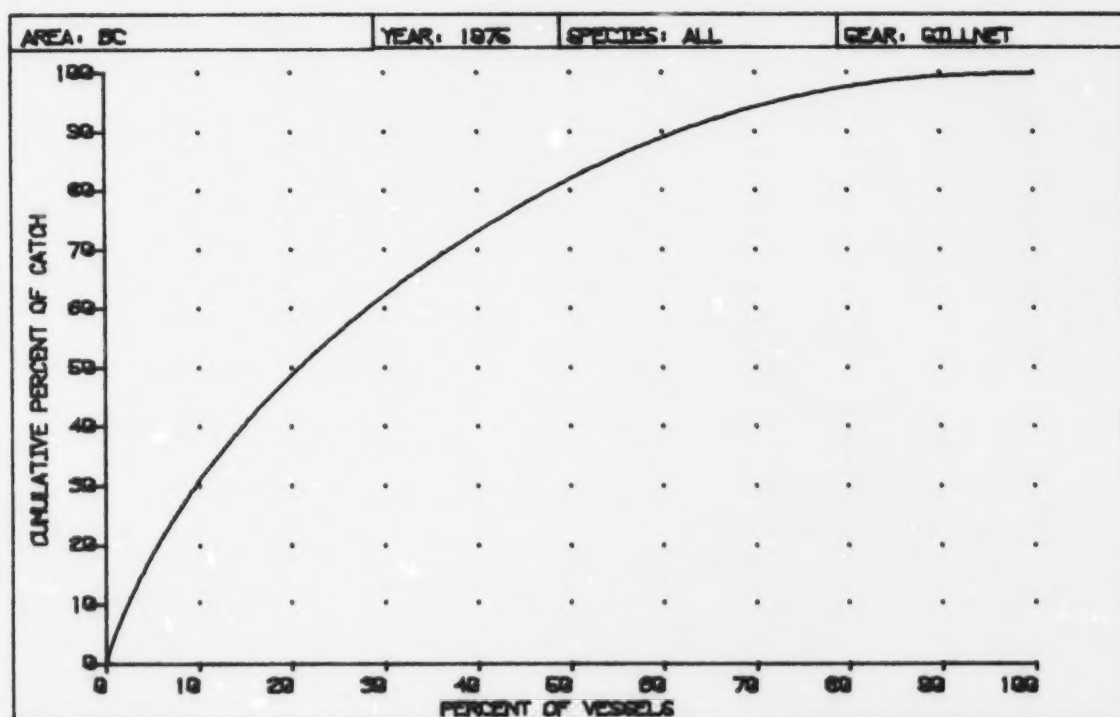
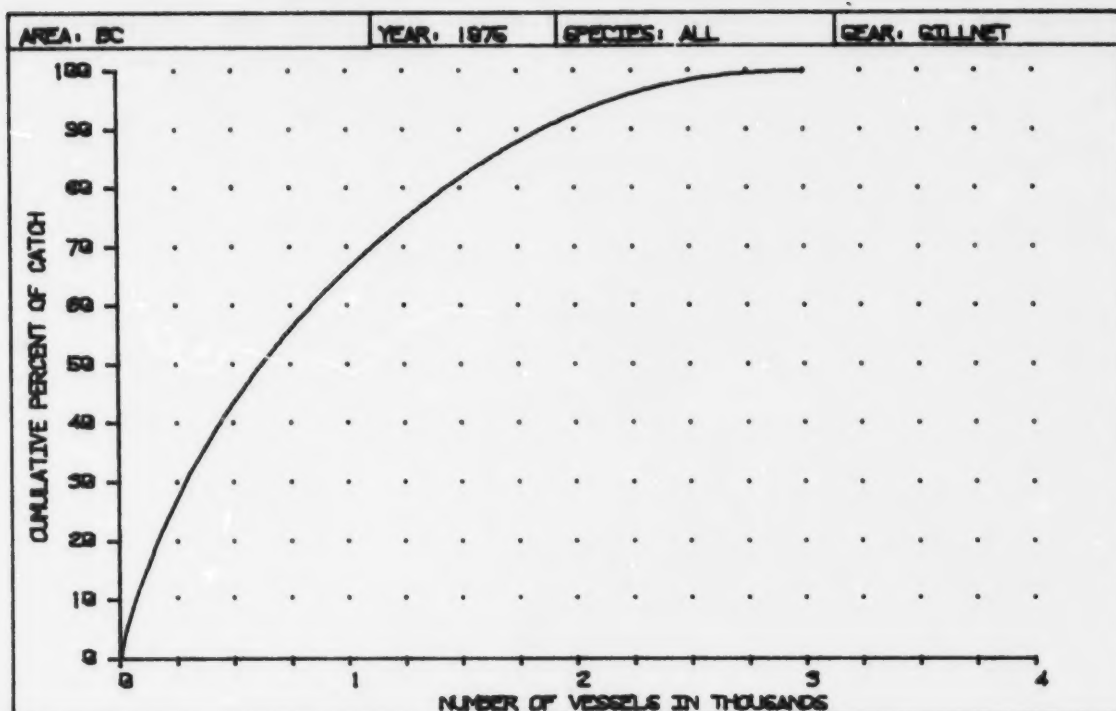


Figure A9. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1975.

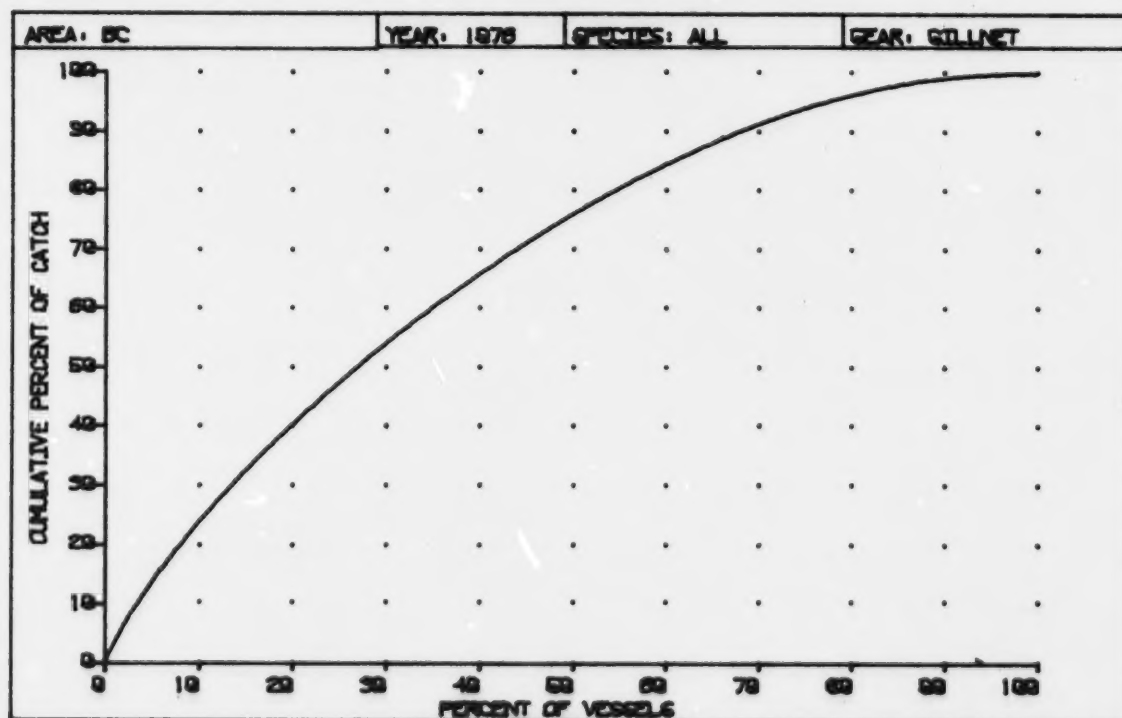
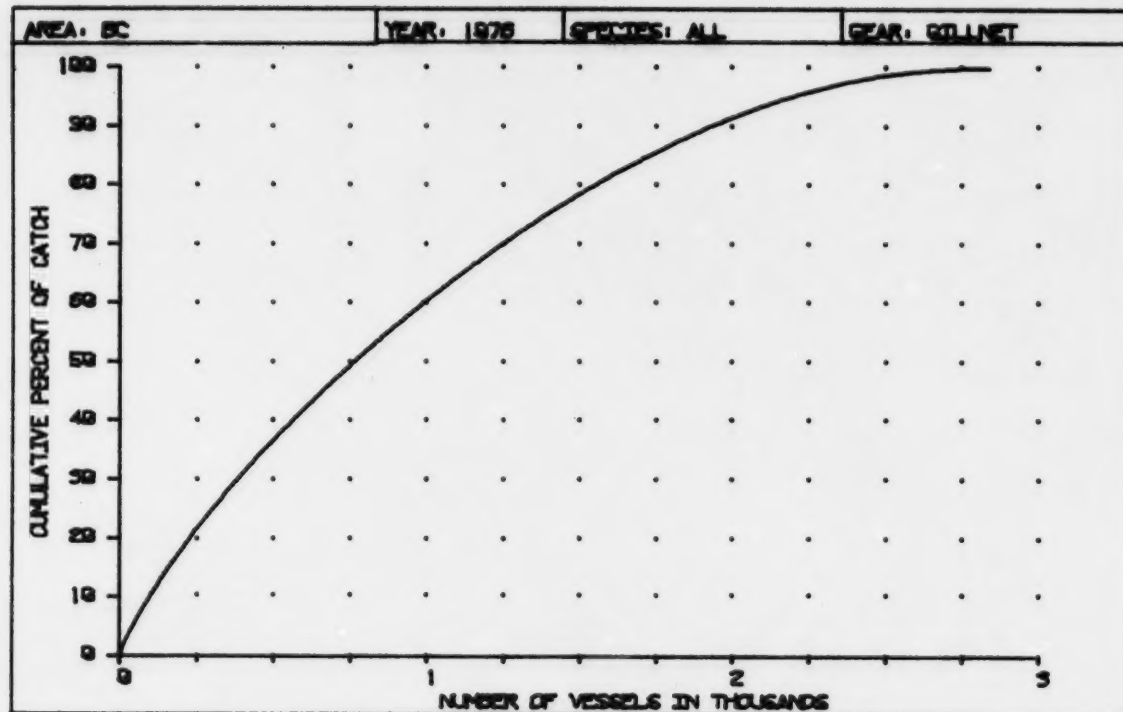


Figure A10. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1976.

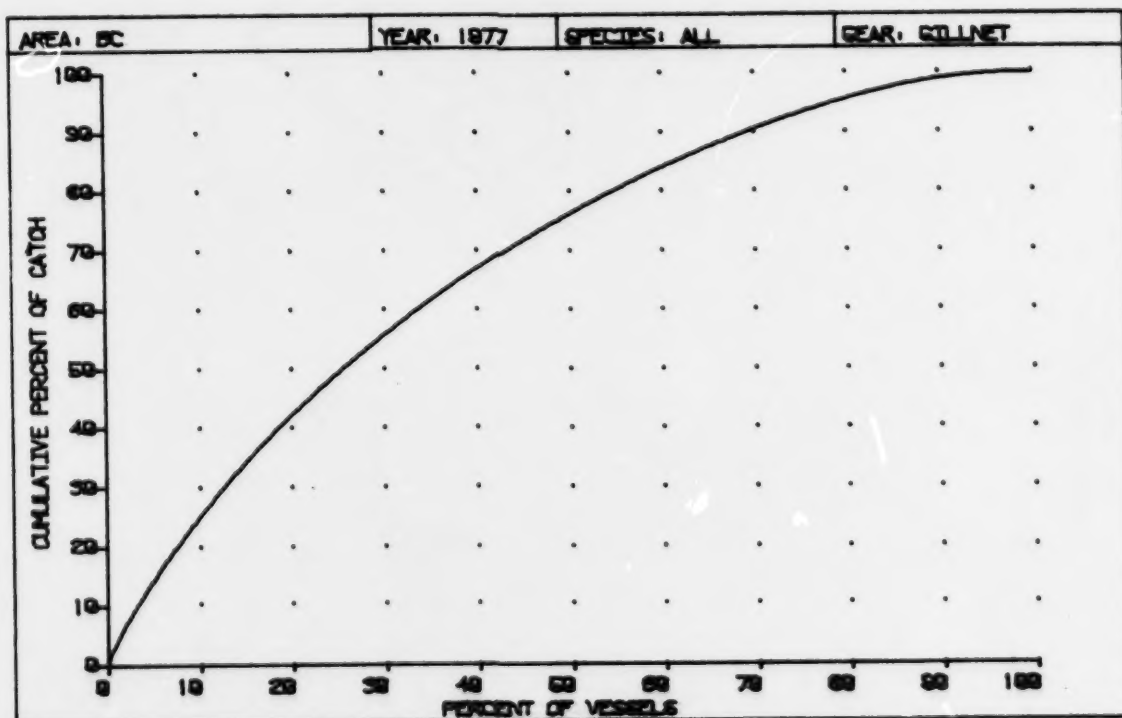
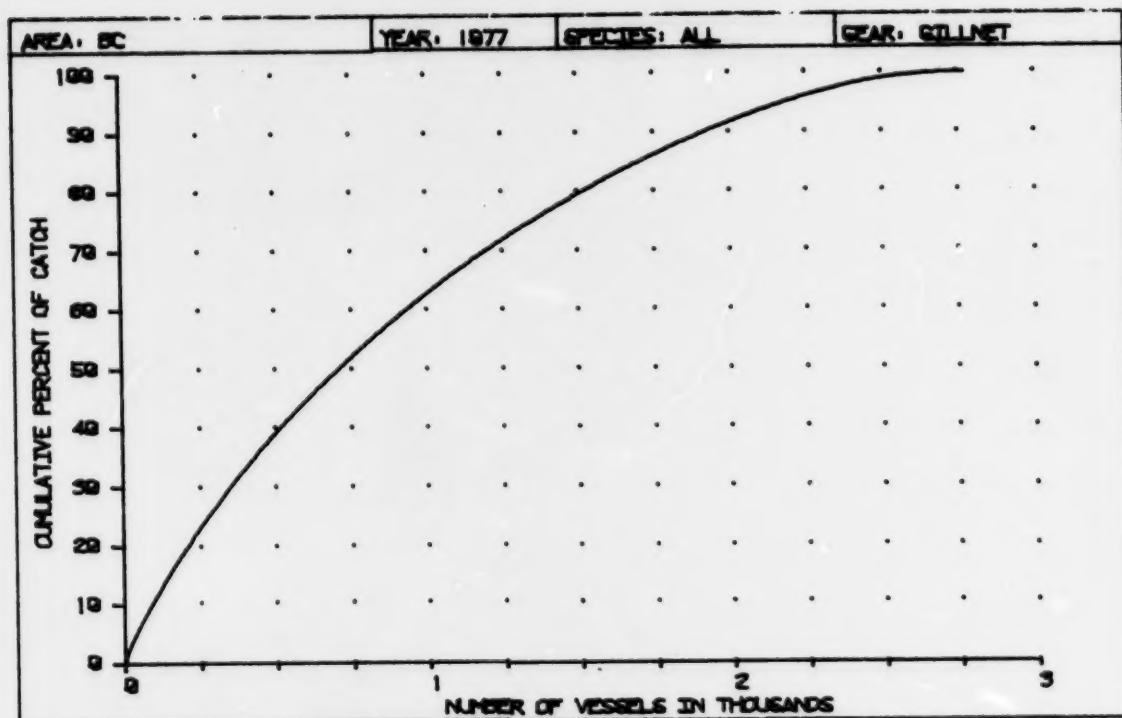


Figure A11. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1977.

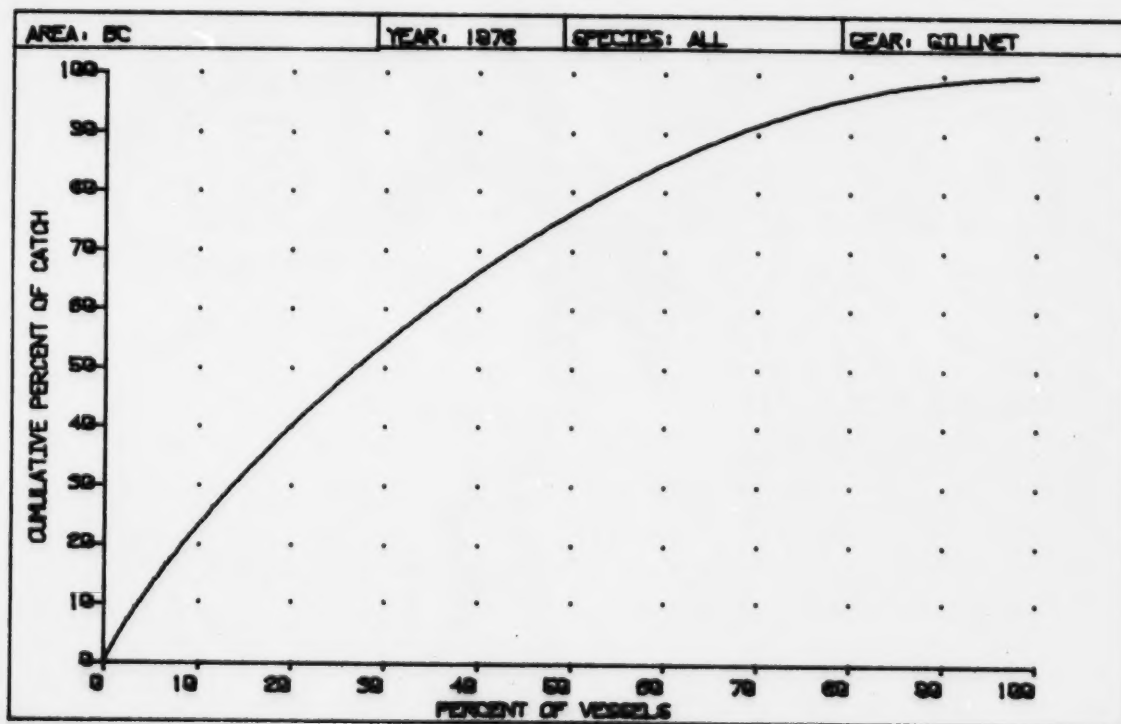
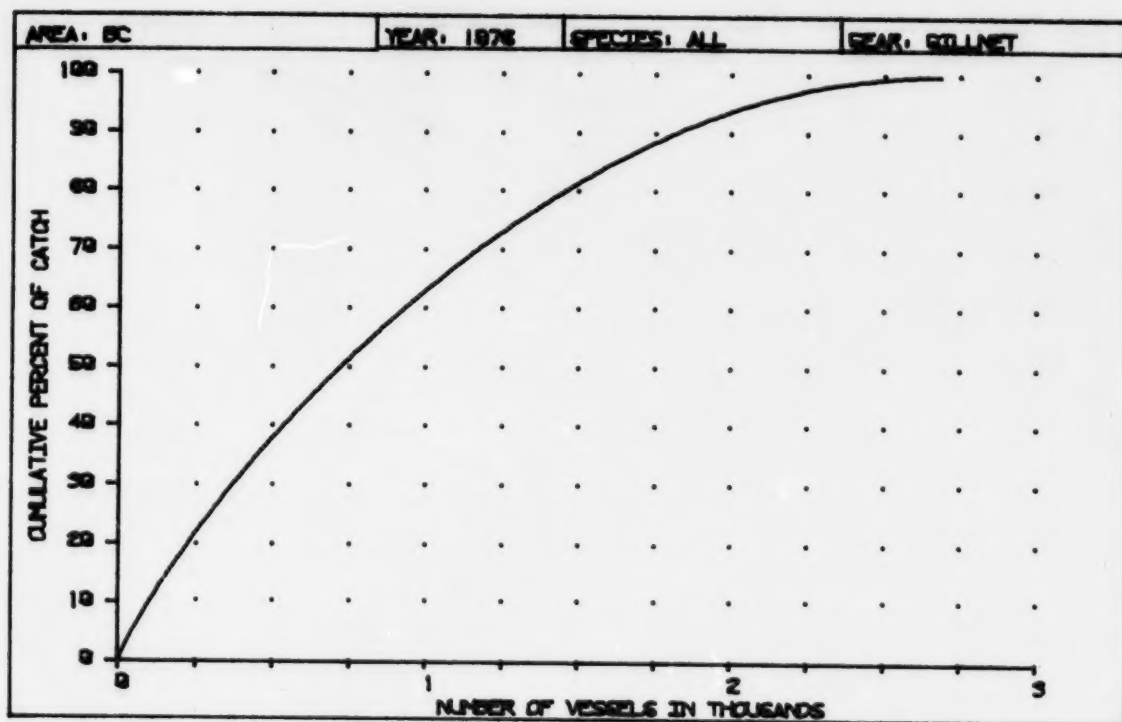


Figure A12. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1978.

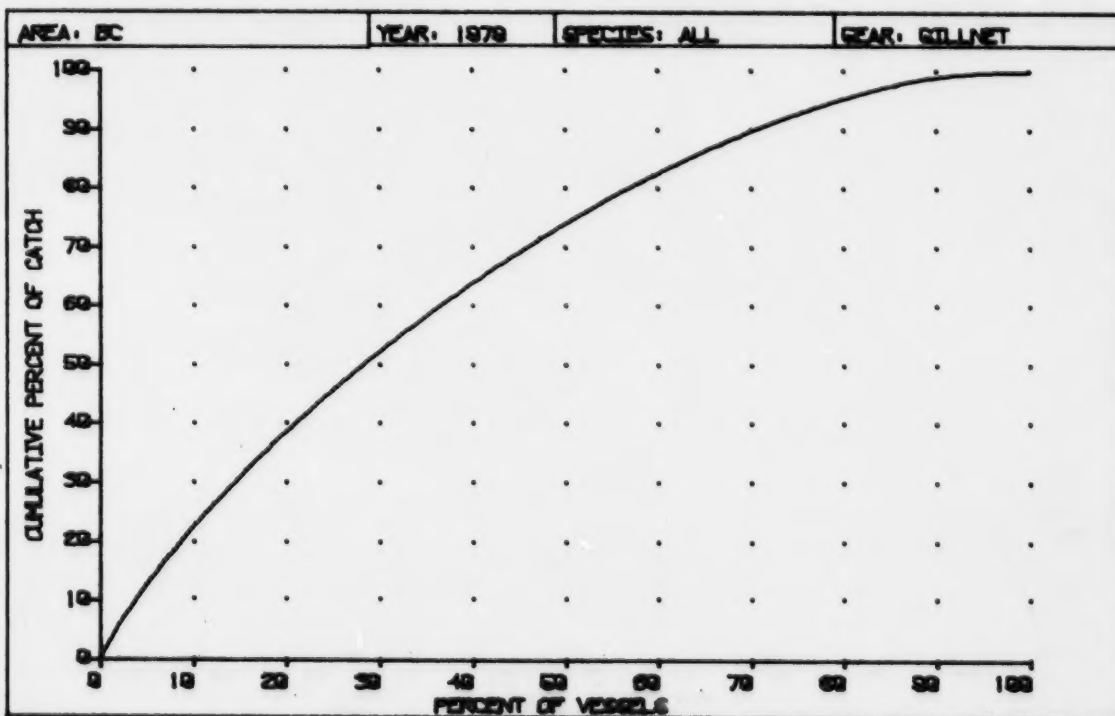
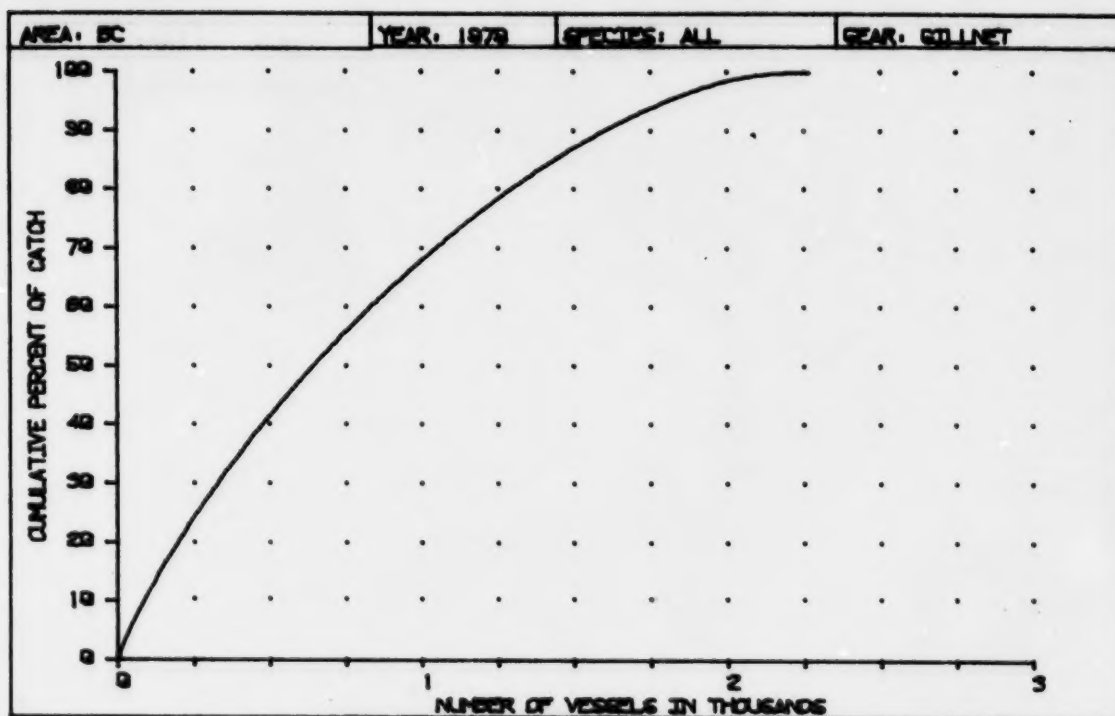


Figure A13. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1979.

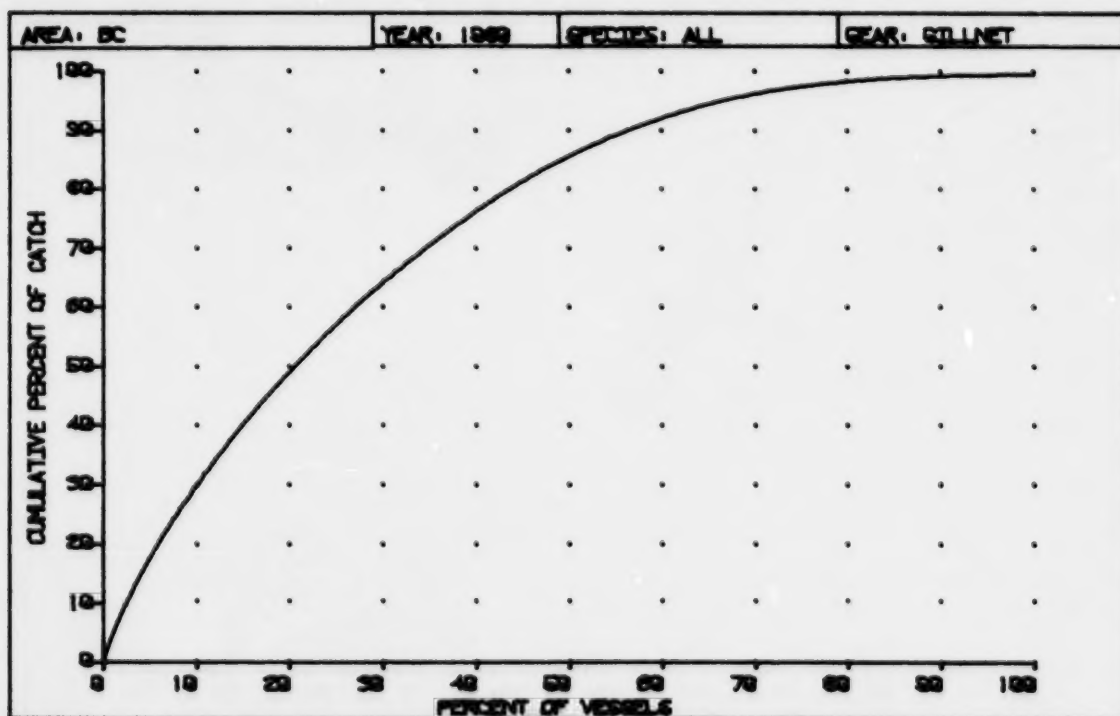
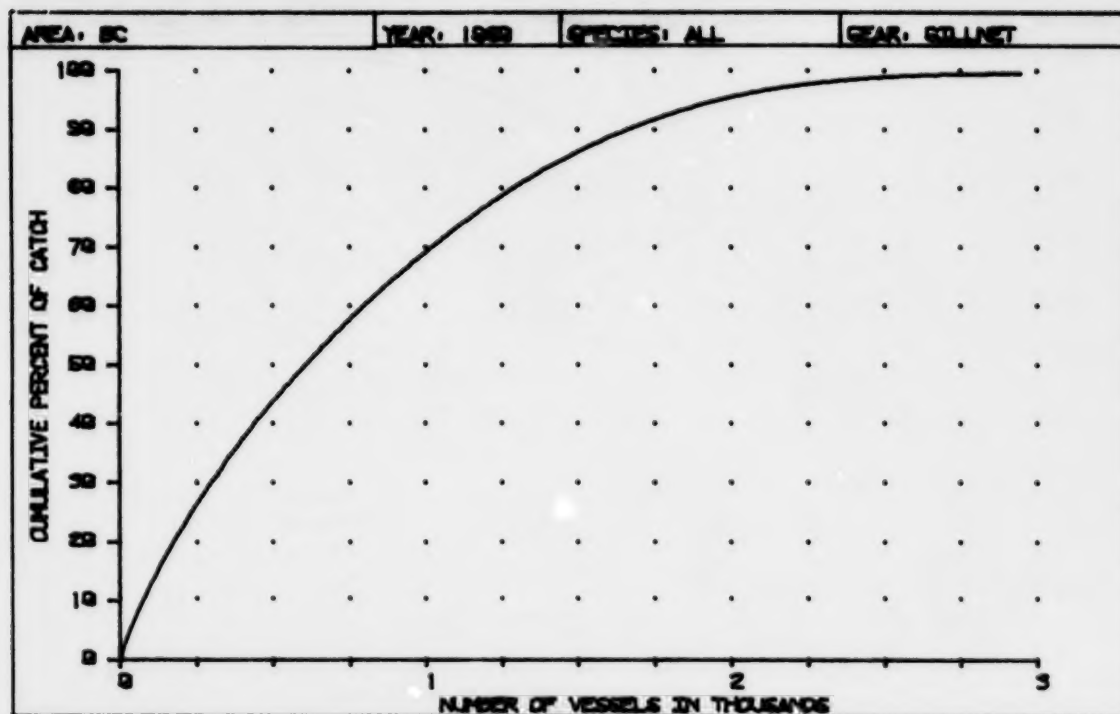


Figure A14. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1980.

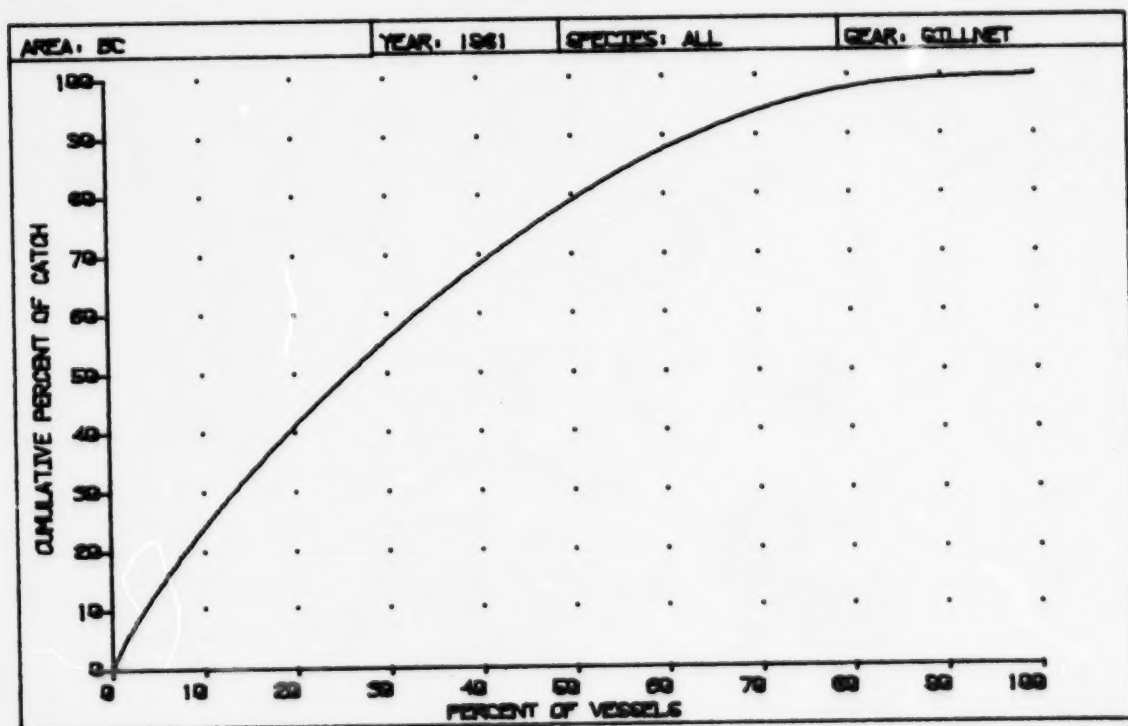
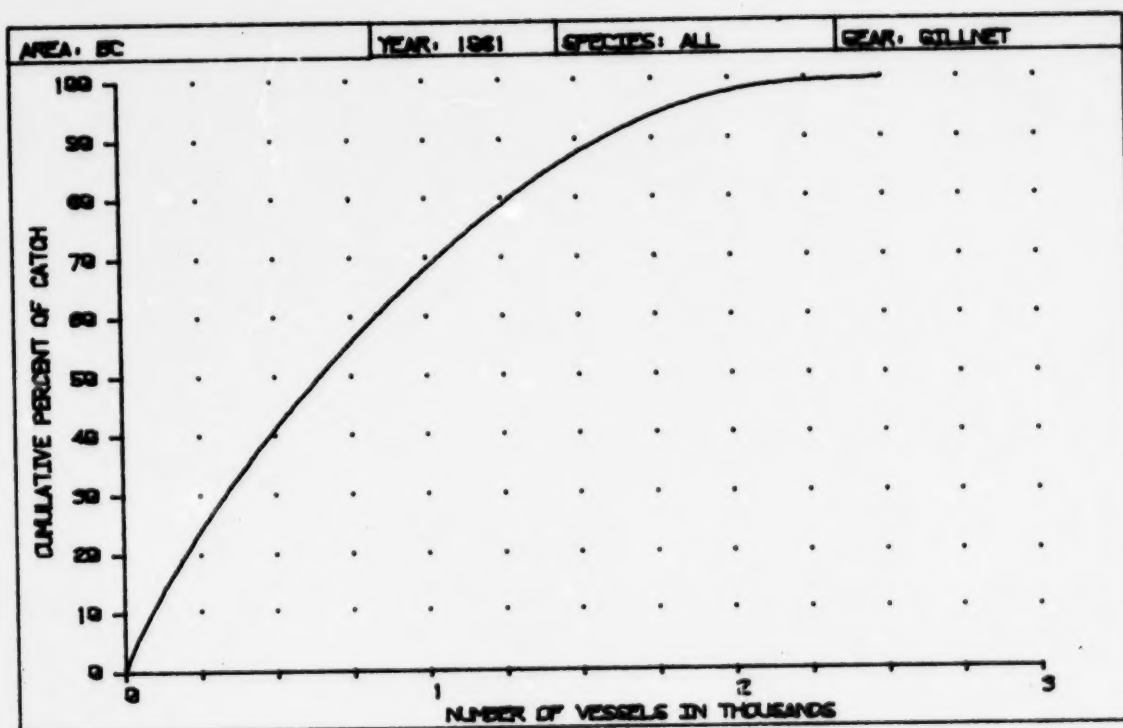


Figure A15. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used gillnets and participated in the fishery, 1981.

APPENDIX B

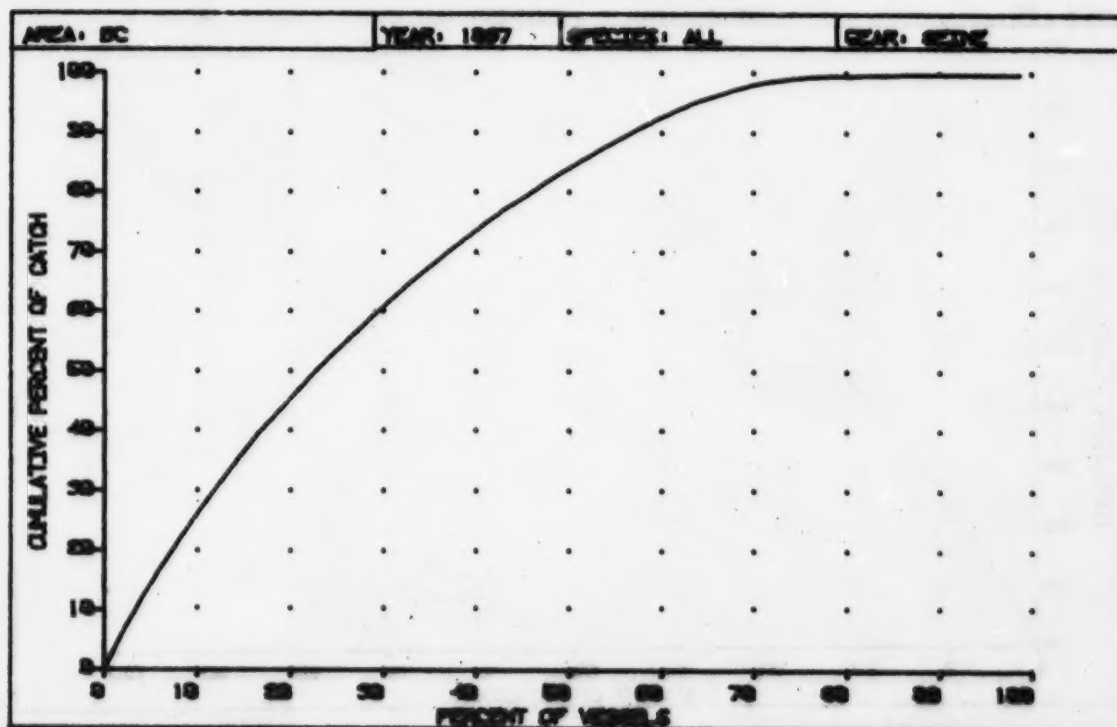
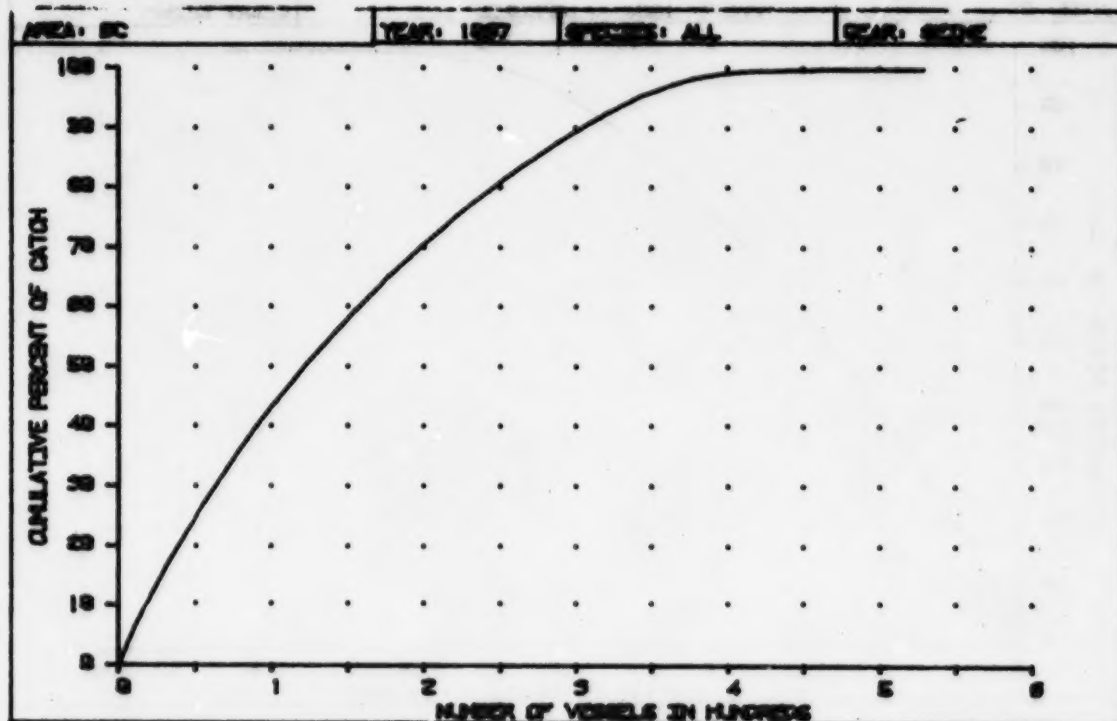


Figure B1. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1967.

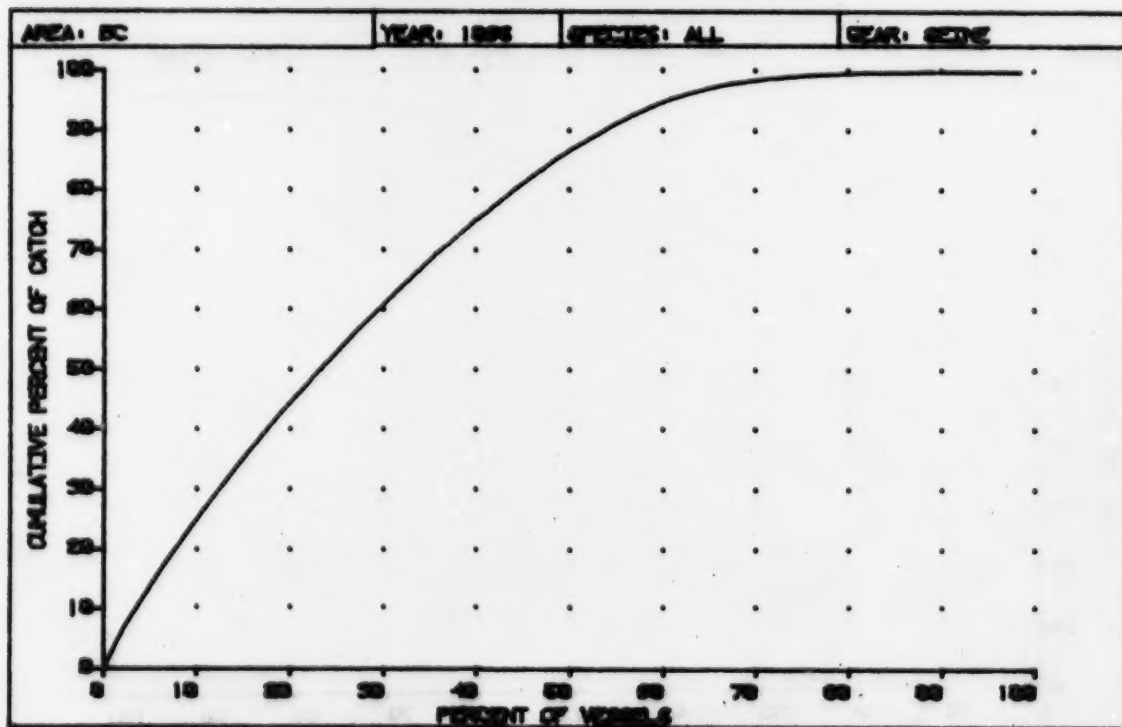
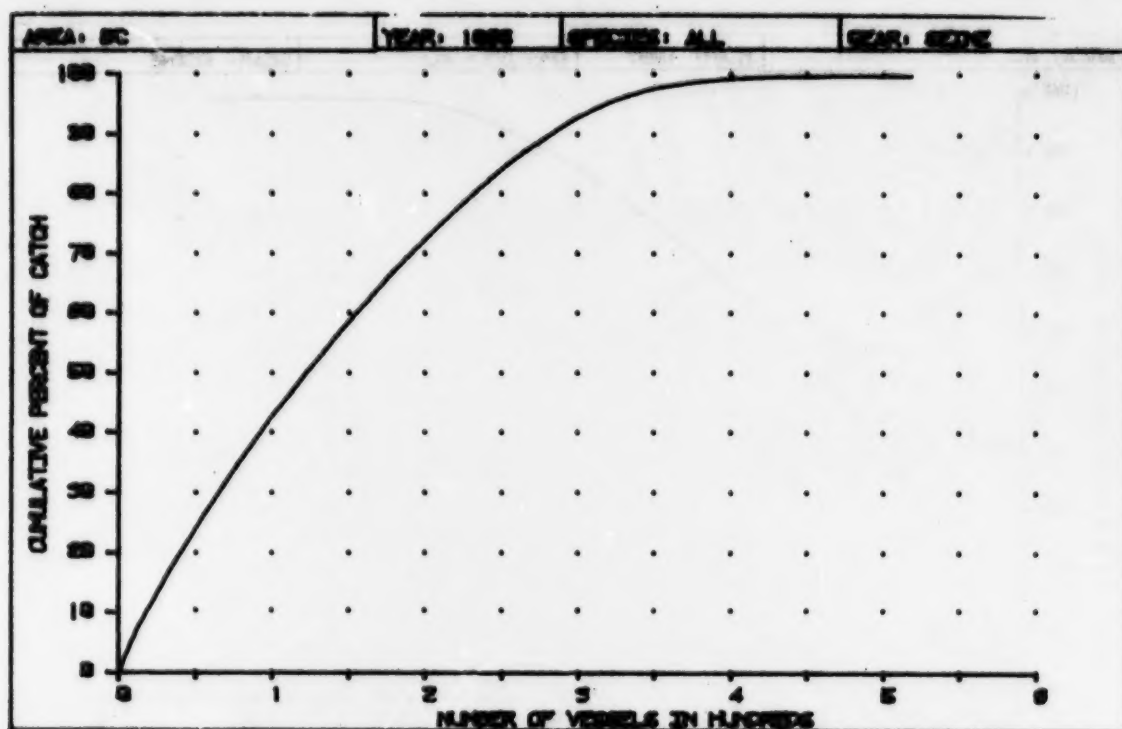


Figure B2. Cumulative percent of catch of Pacific salmon versus the number and percent of purse seiners that participated in the fishery, 1968.

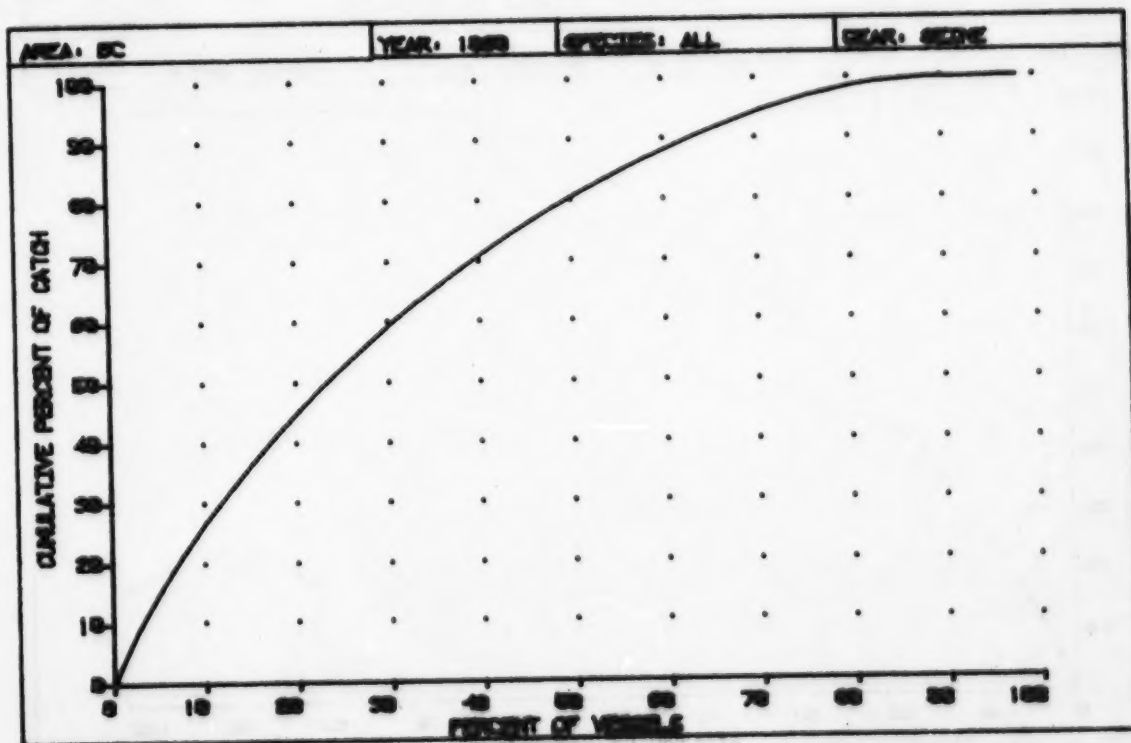
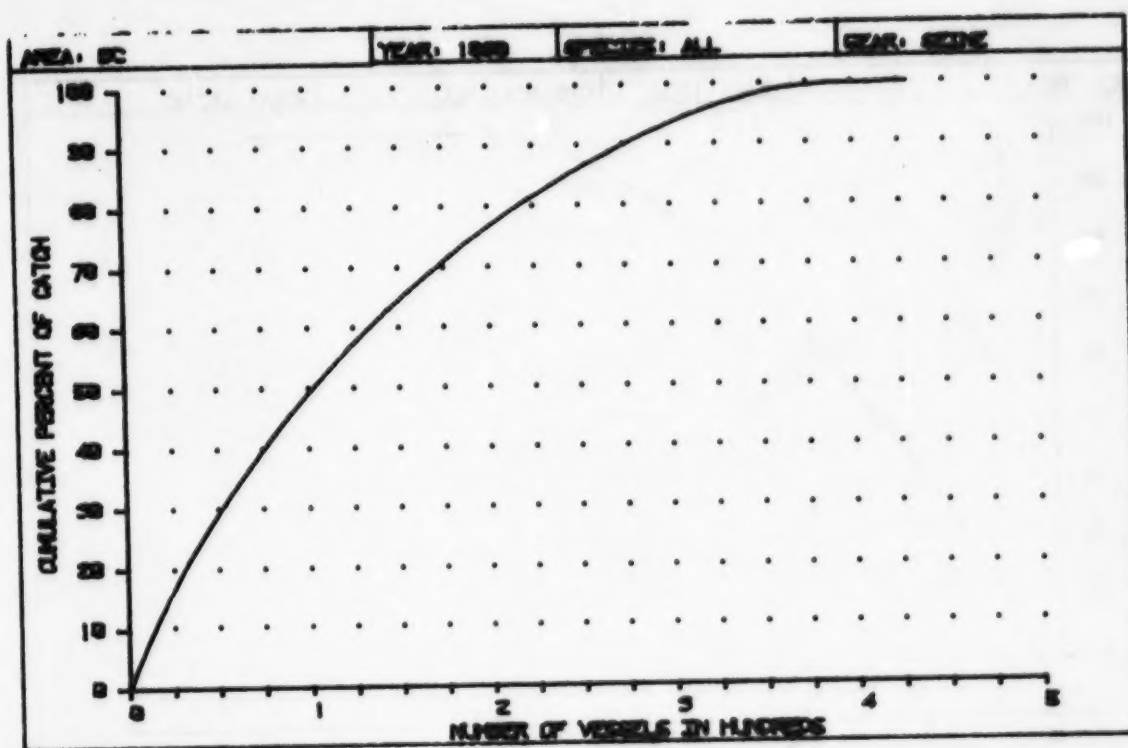


Figure B3. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1969.

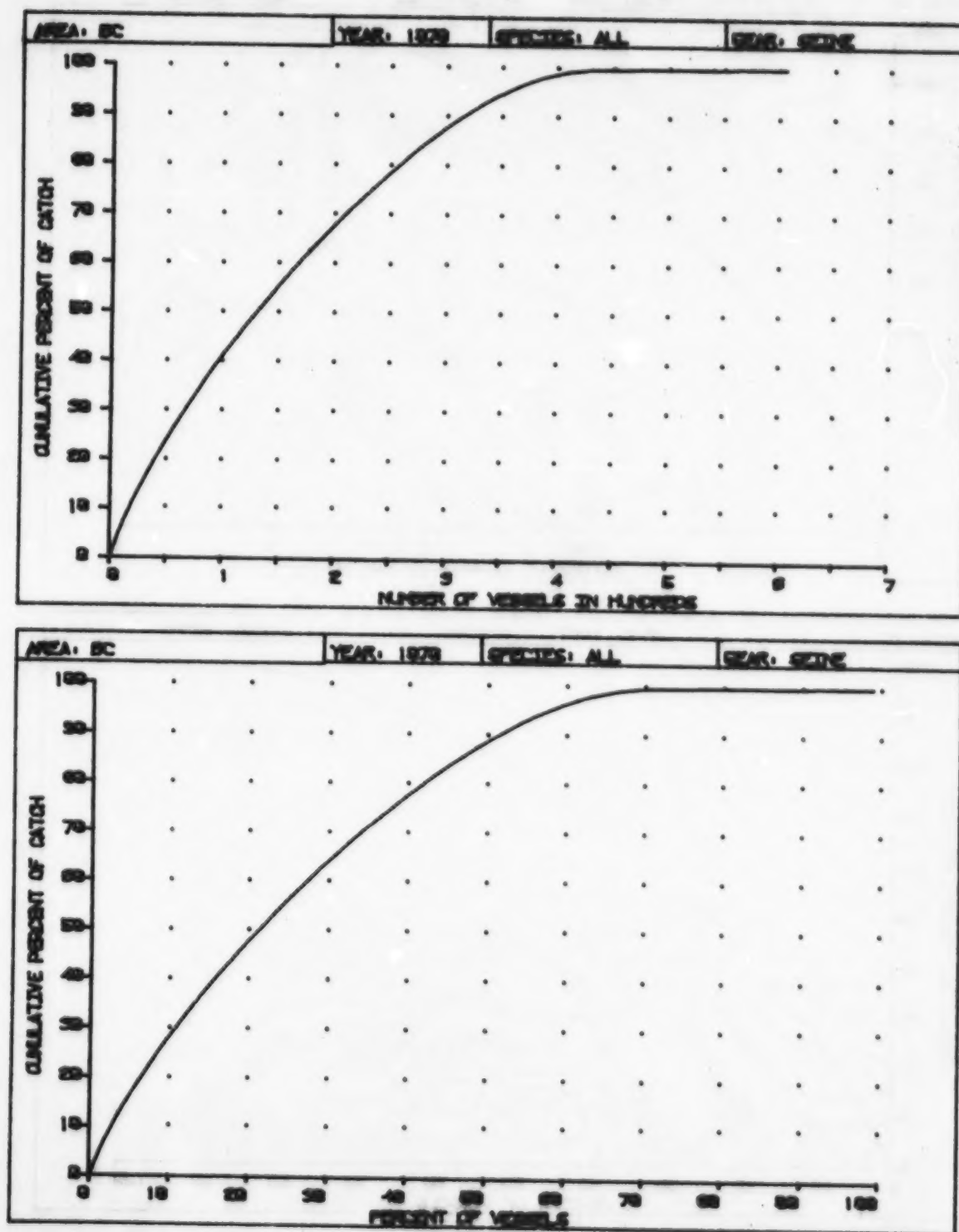


Figure B4. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1970.

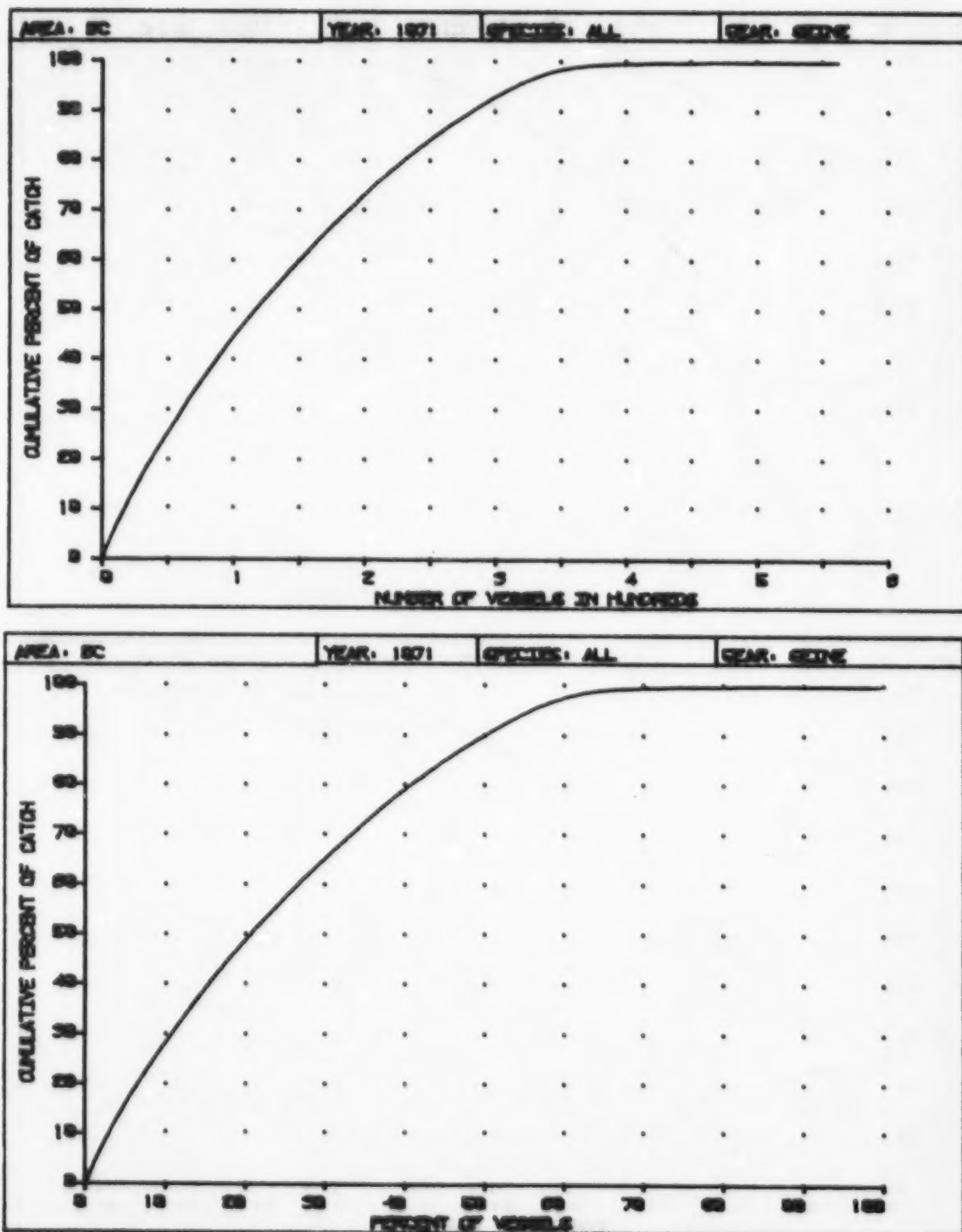


Figure B5. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1971.

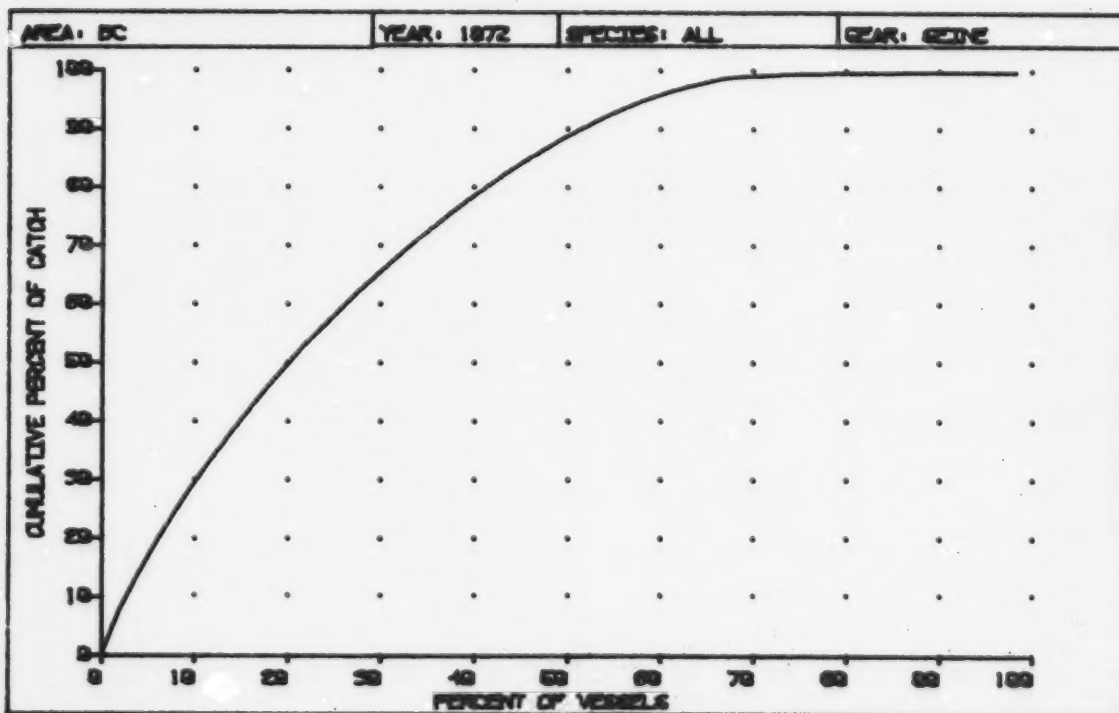
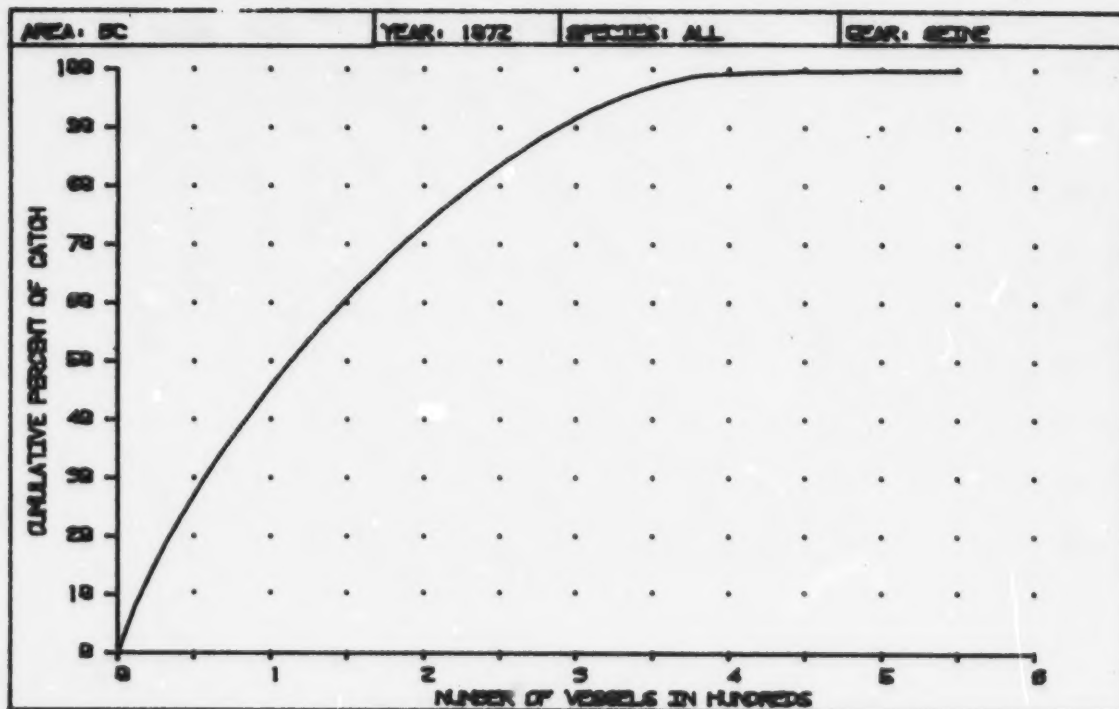


Figure B6. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1972.

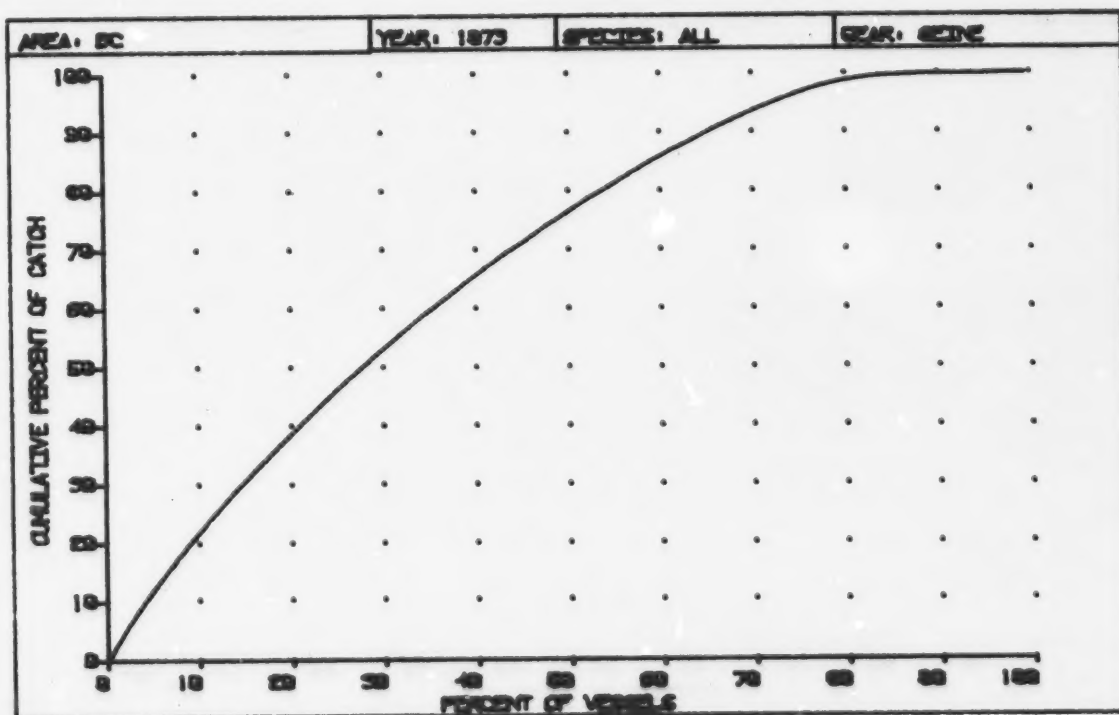
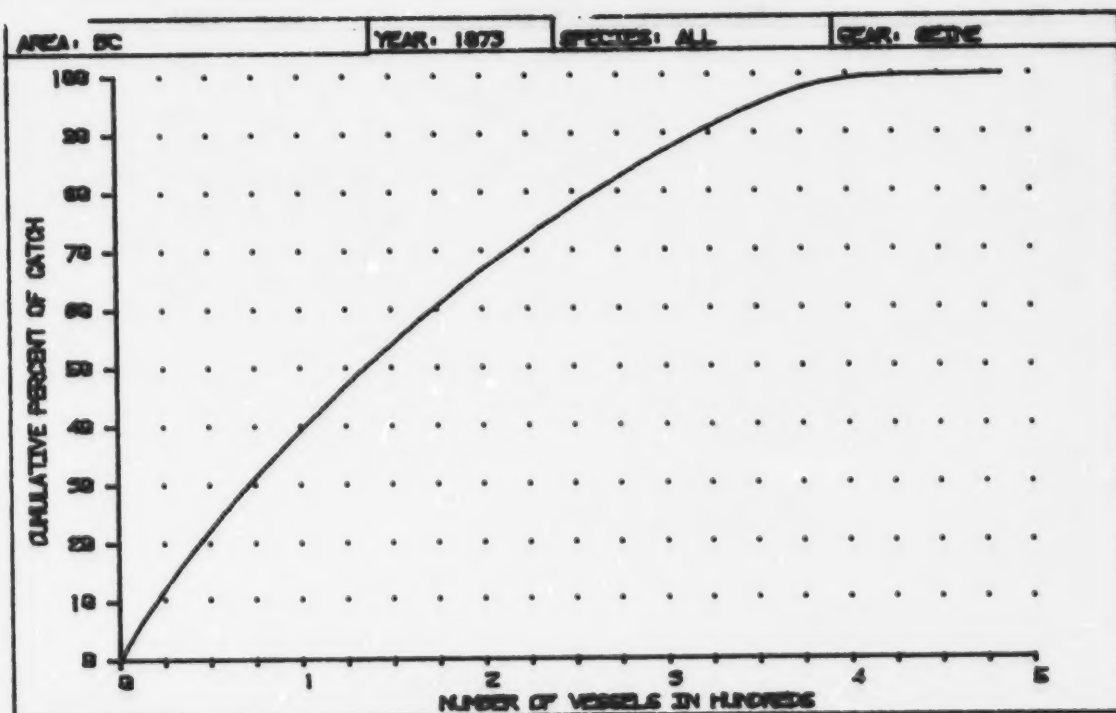


Figure B7. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1973.

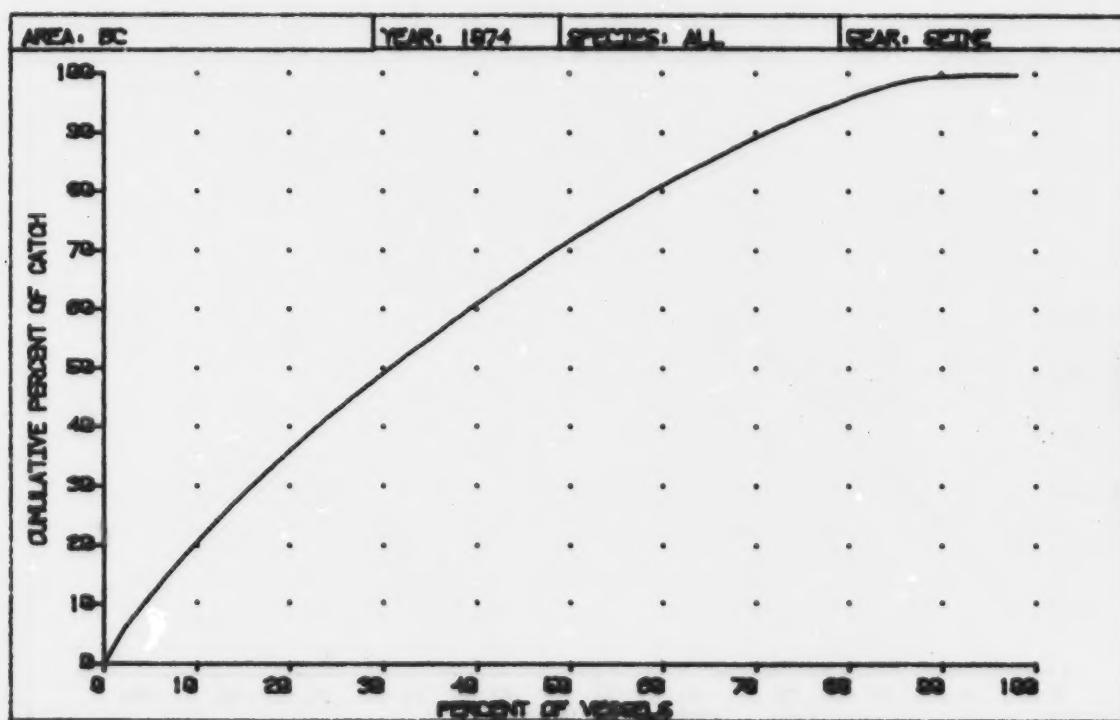
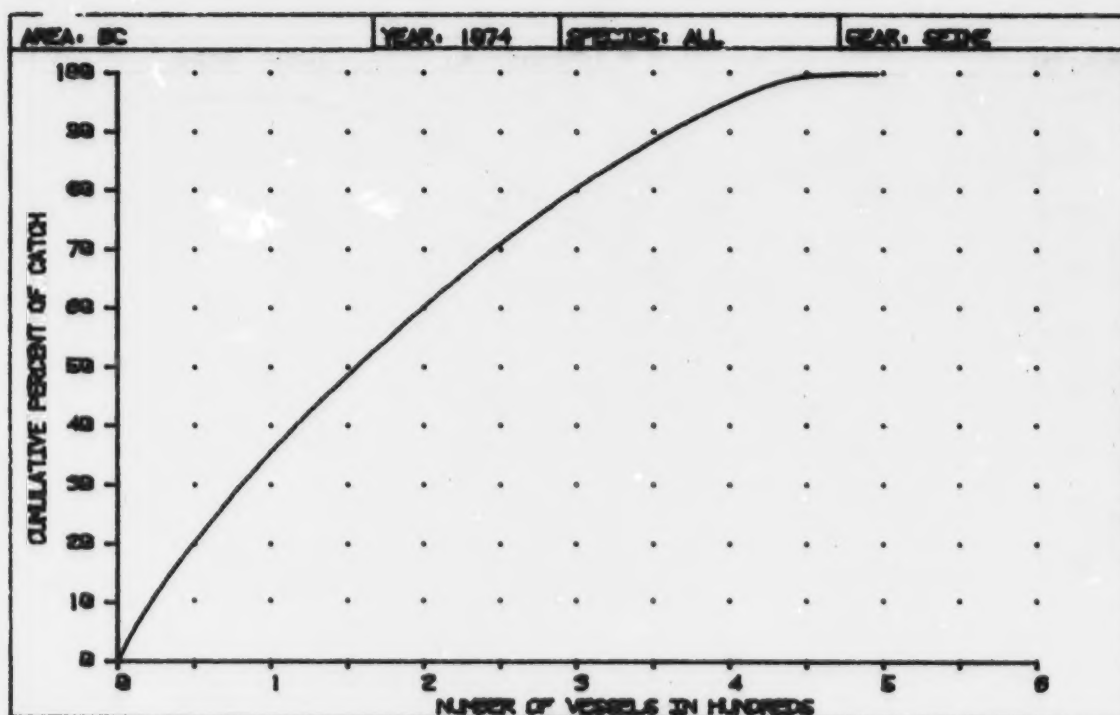


Figure B8. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1974.

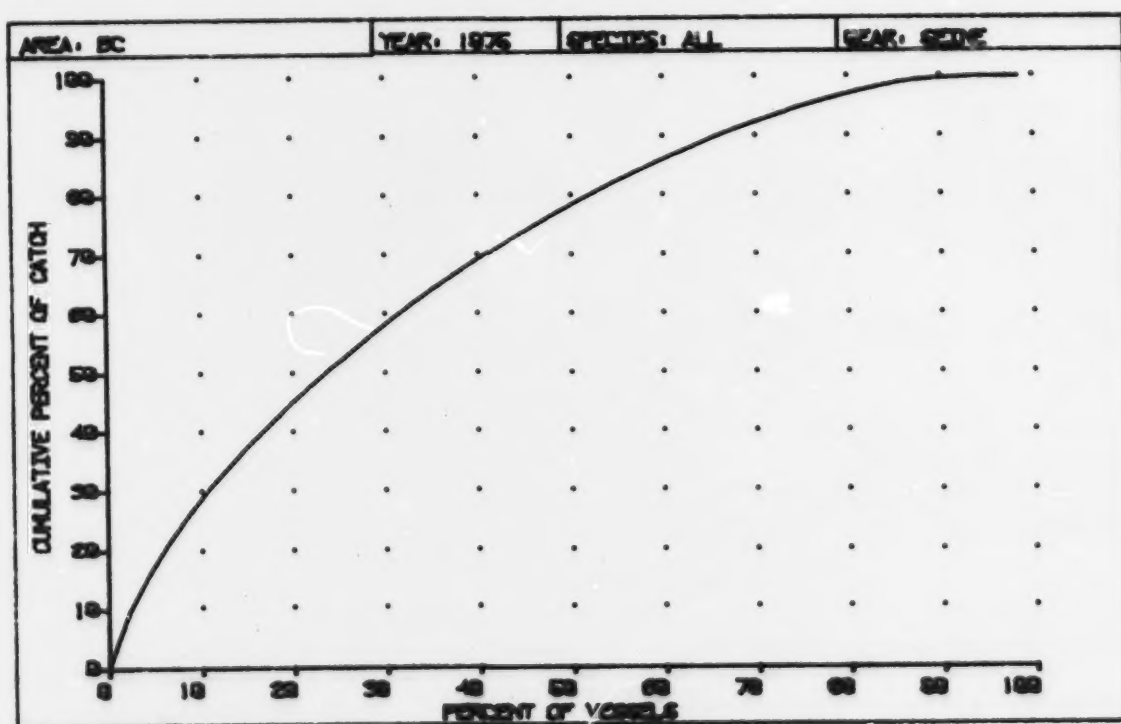
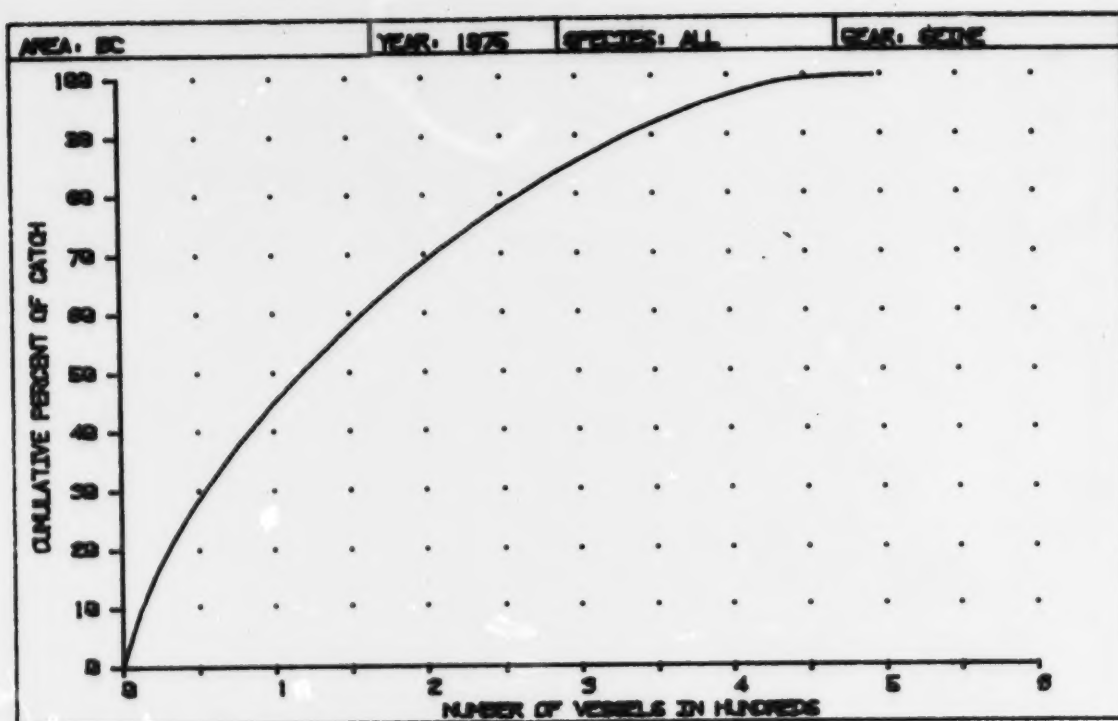


Figure B9. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1975.

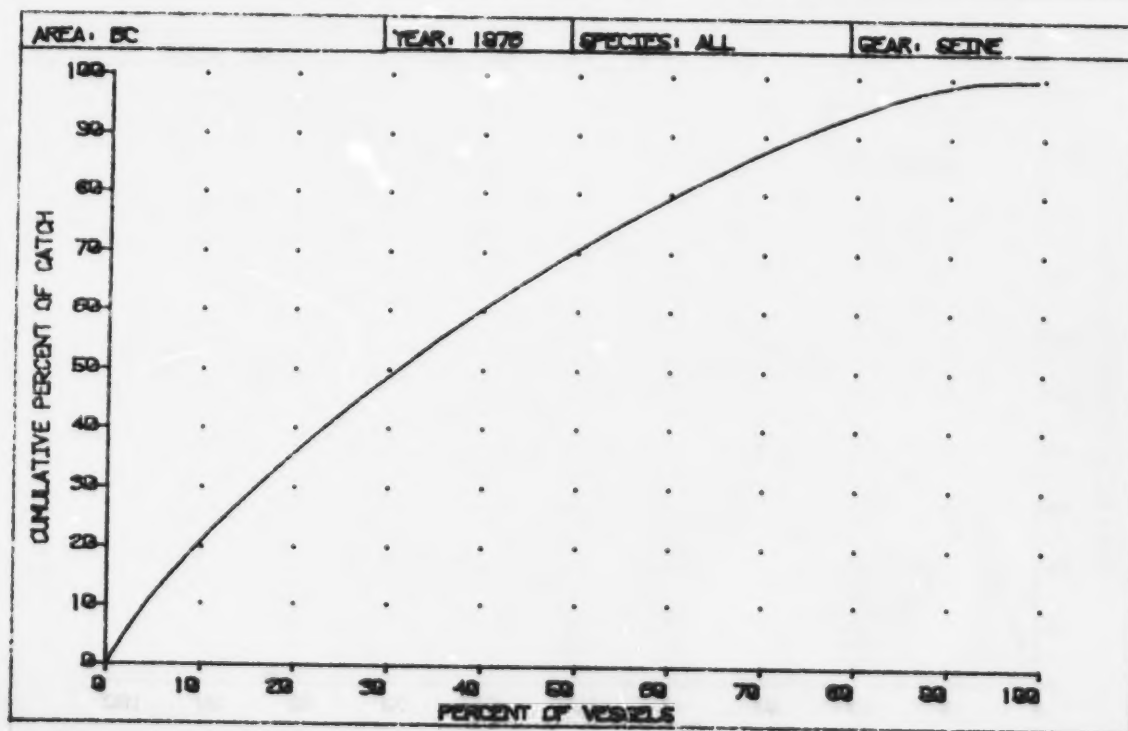
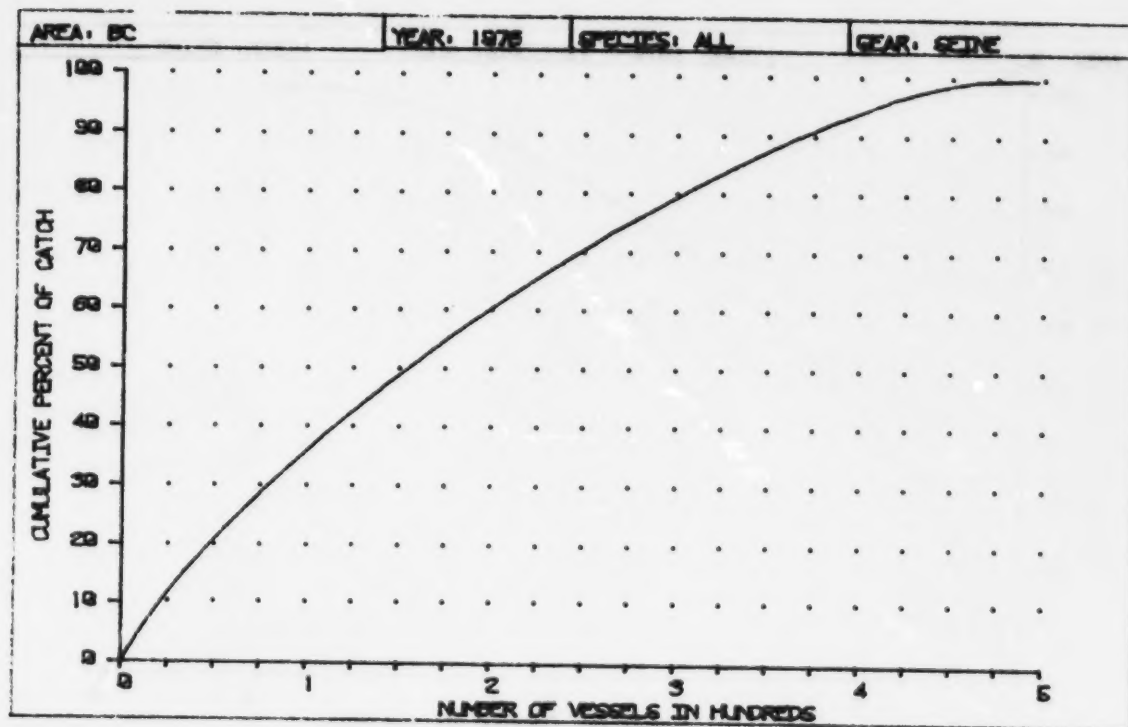


Figure B10. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1976.

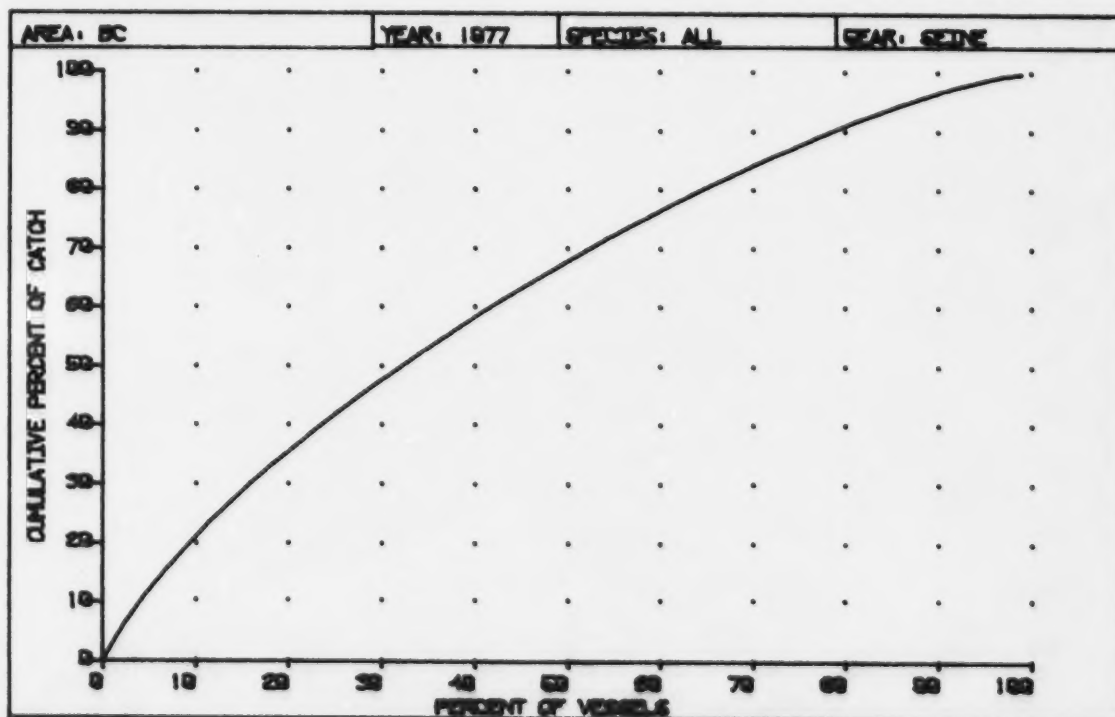
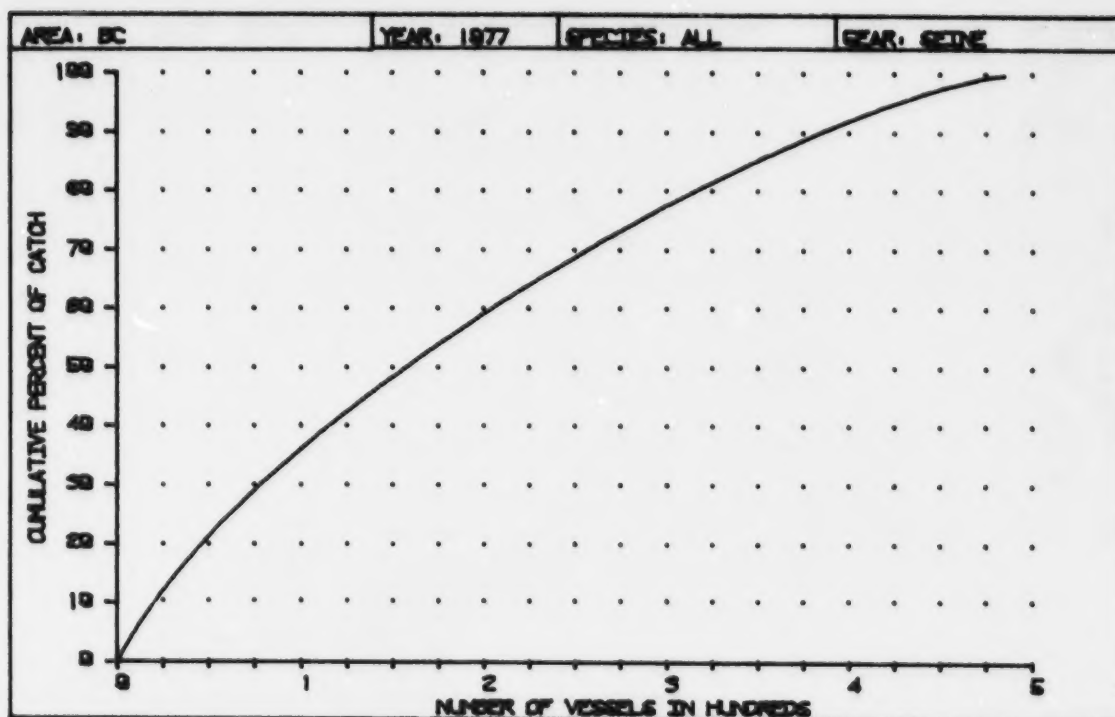


Figure B11. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1977.

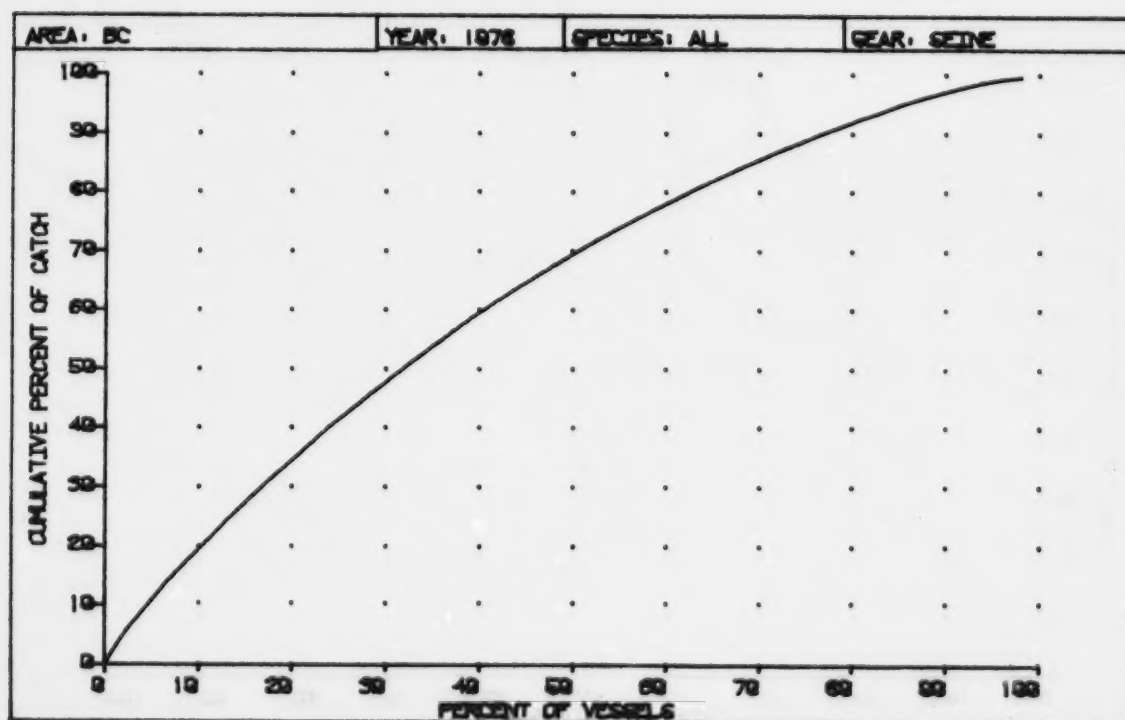
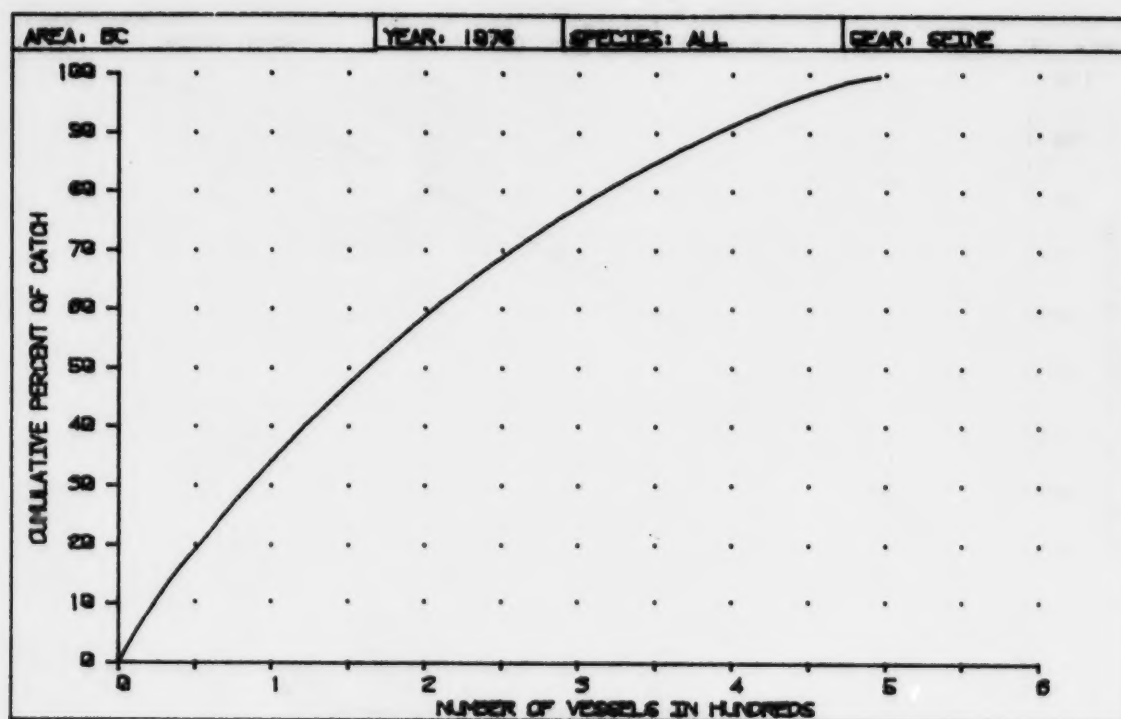


Figure B12. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1978.

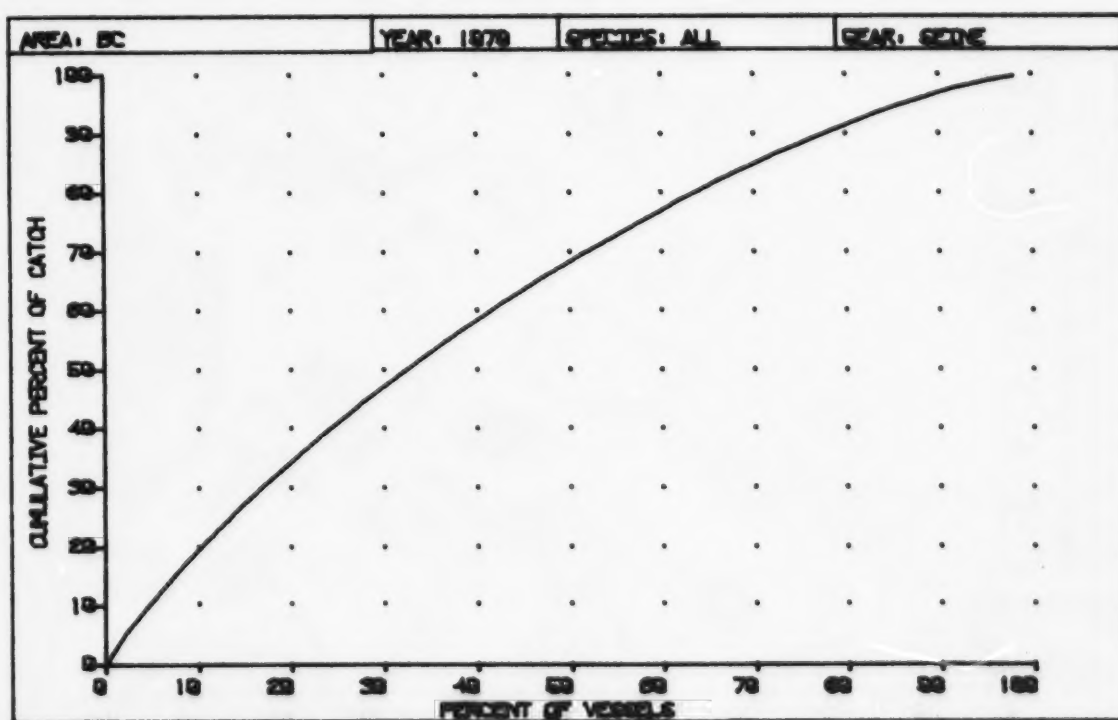
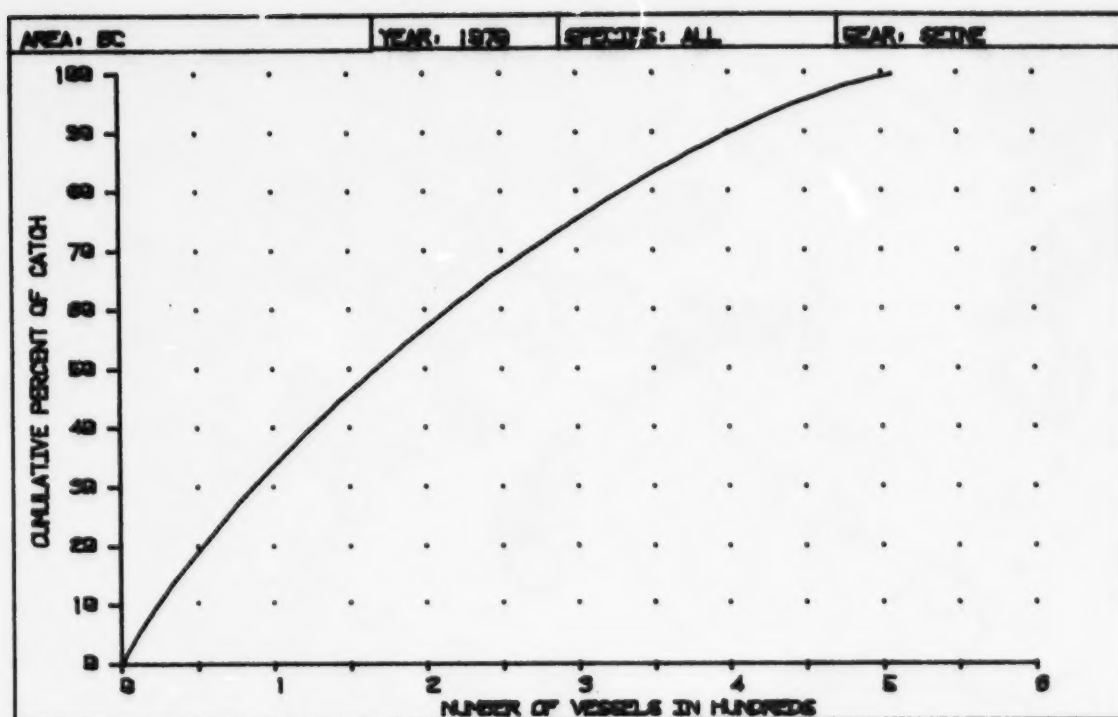


Figure B13. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1979.

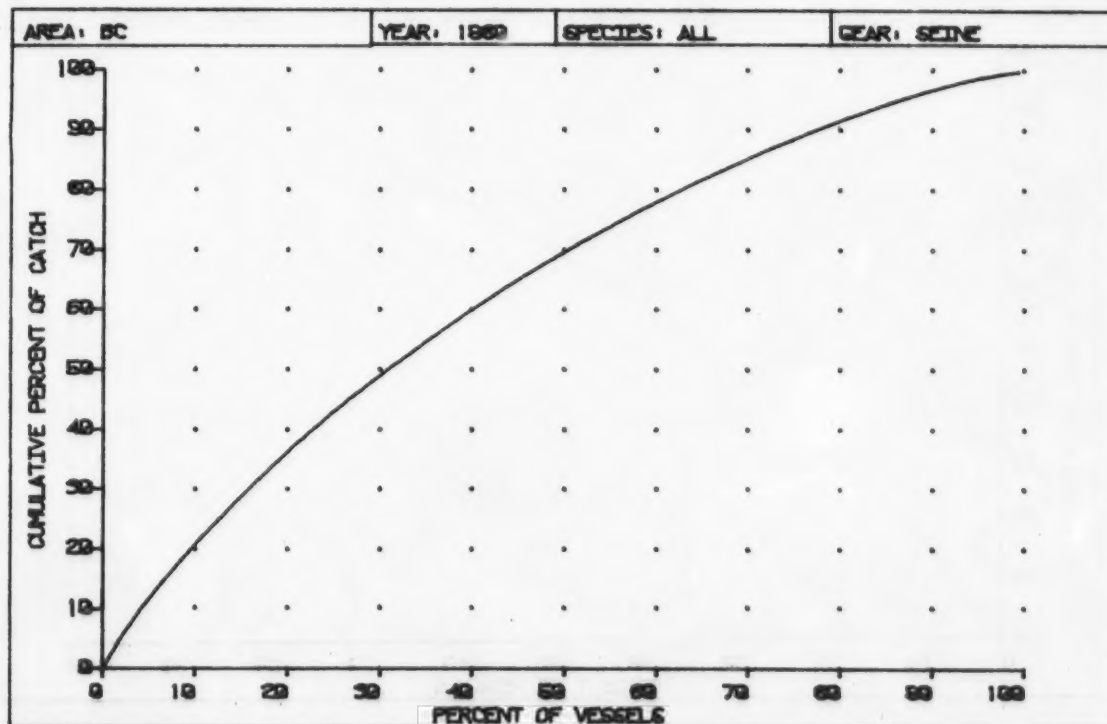
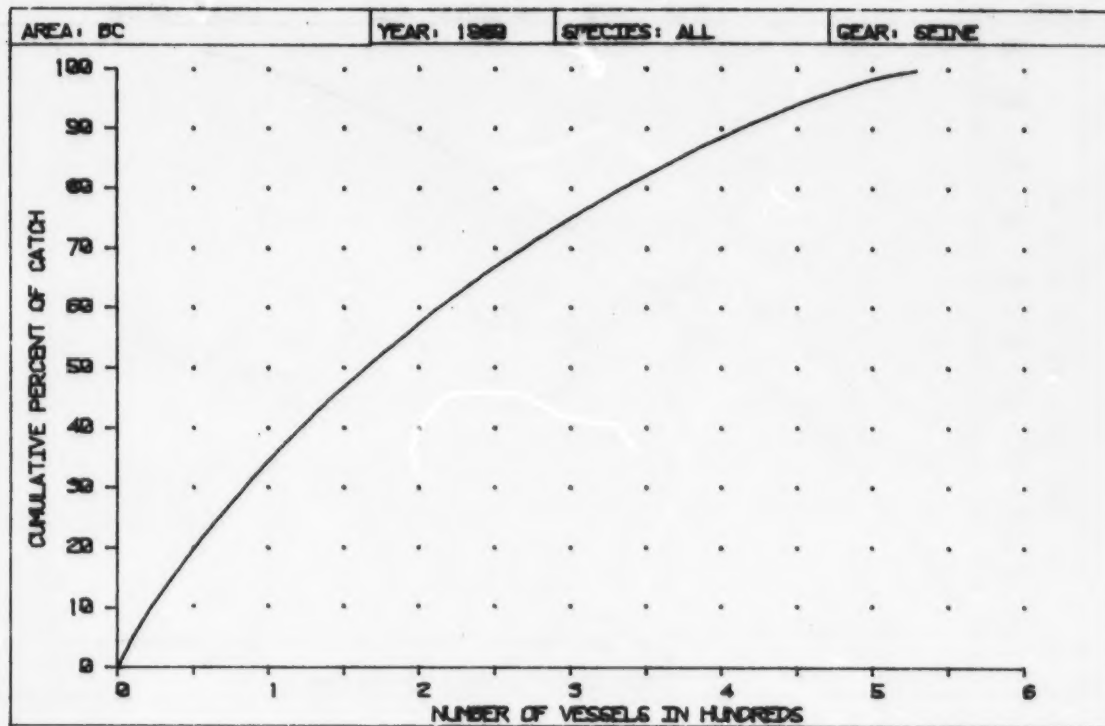


Figure B14. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1980.

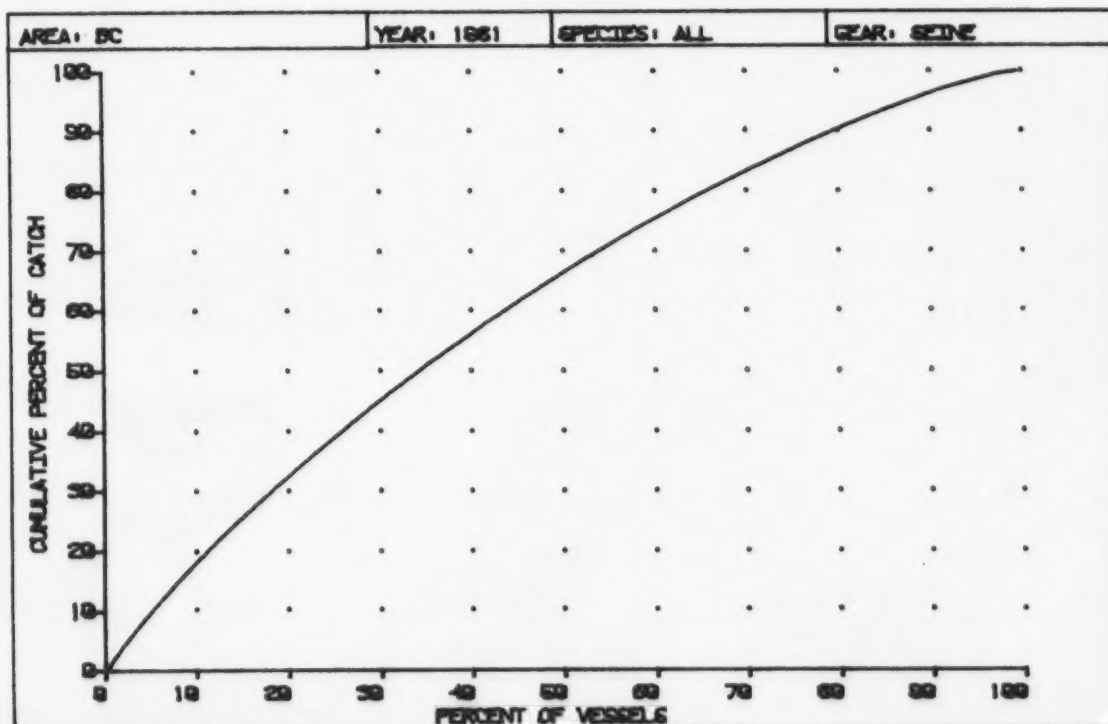
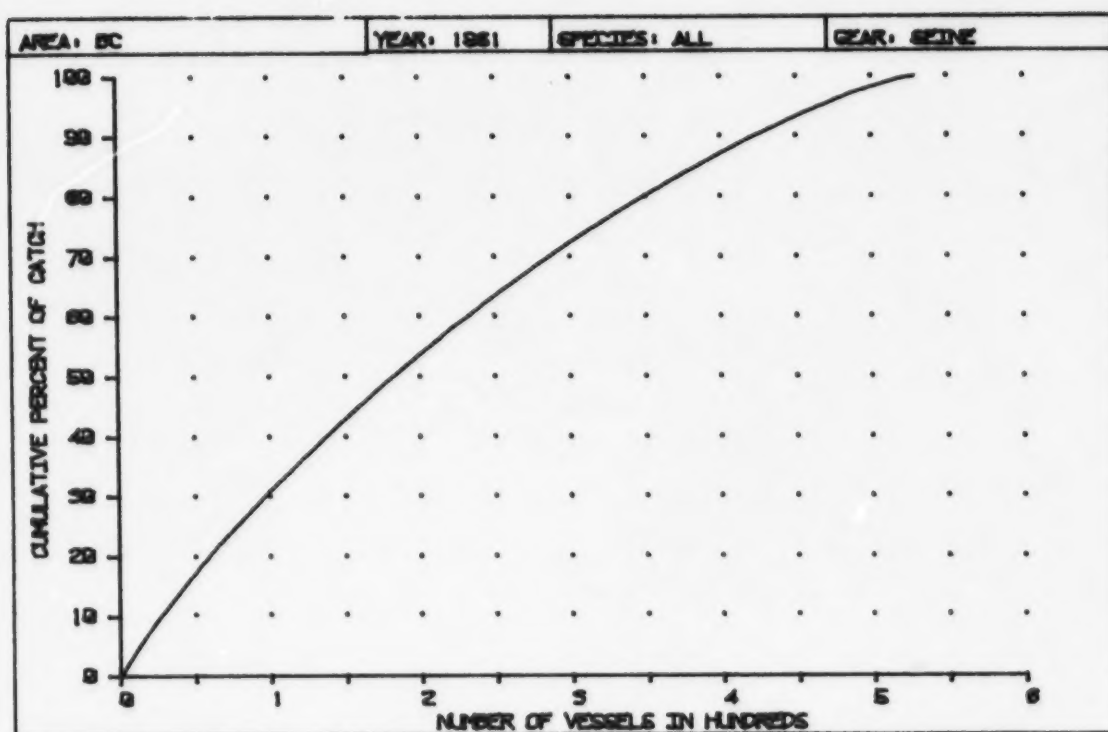


Figure B15. Cumulative percent of catch of Pacific salmon versus number and percent of purse seiners that participated in the fishery, 1981.

APPENDIX C

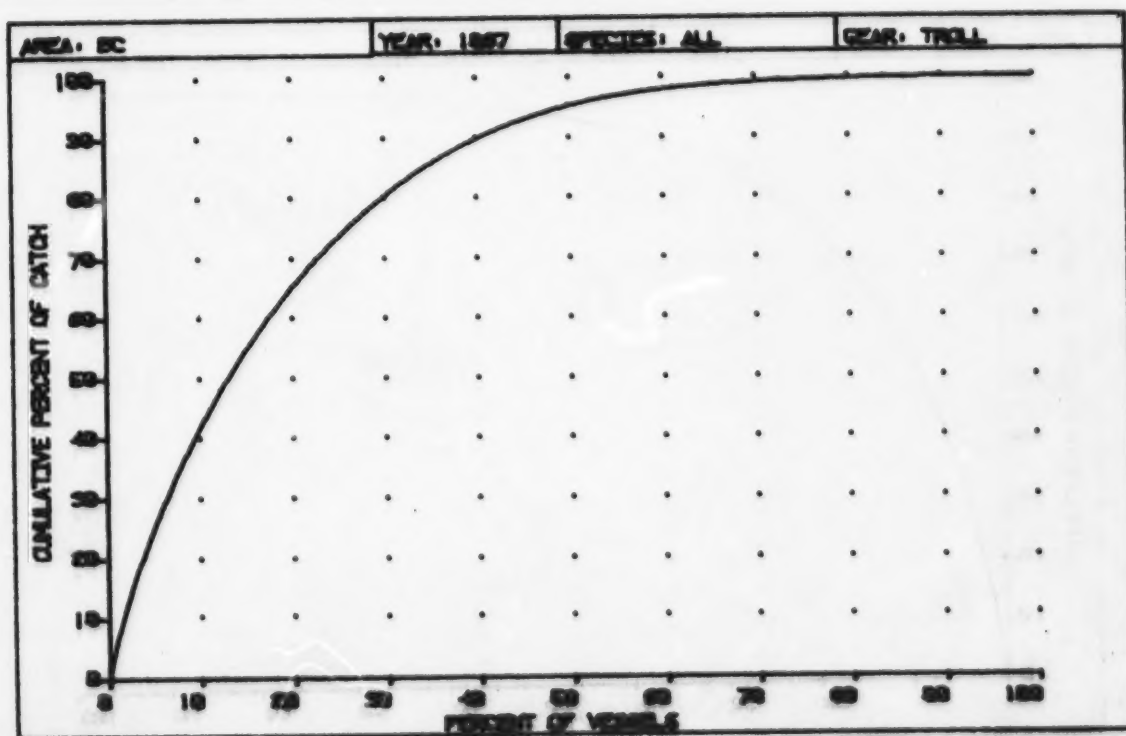
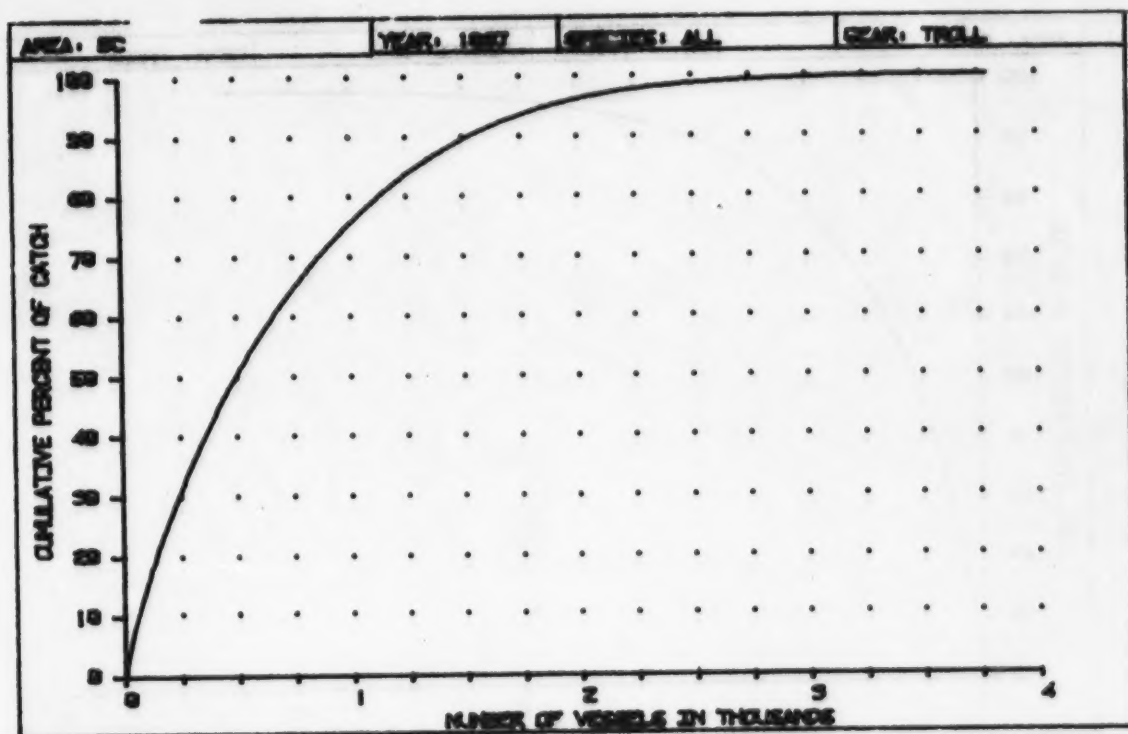


Figure C1. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1967.

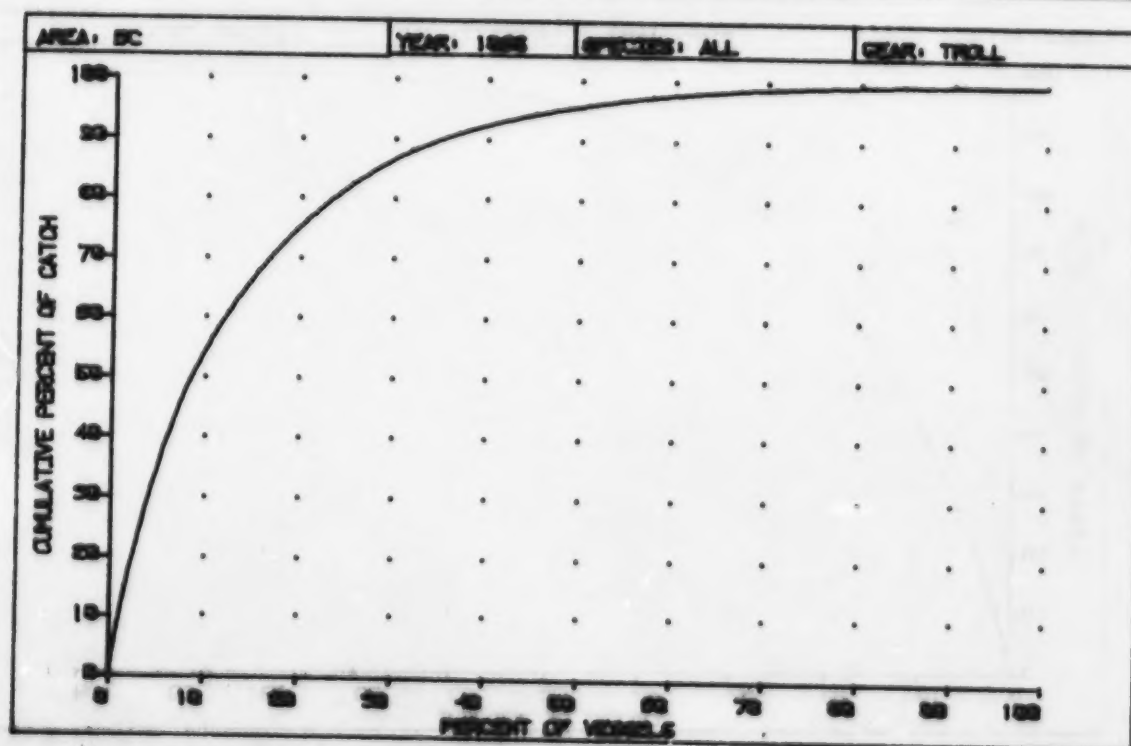
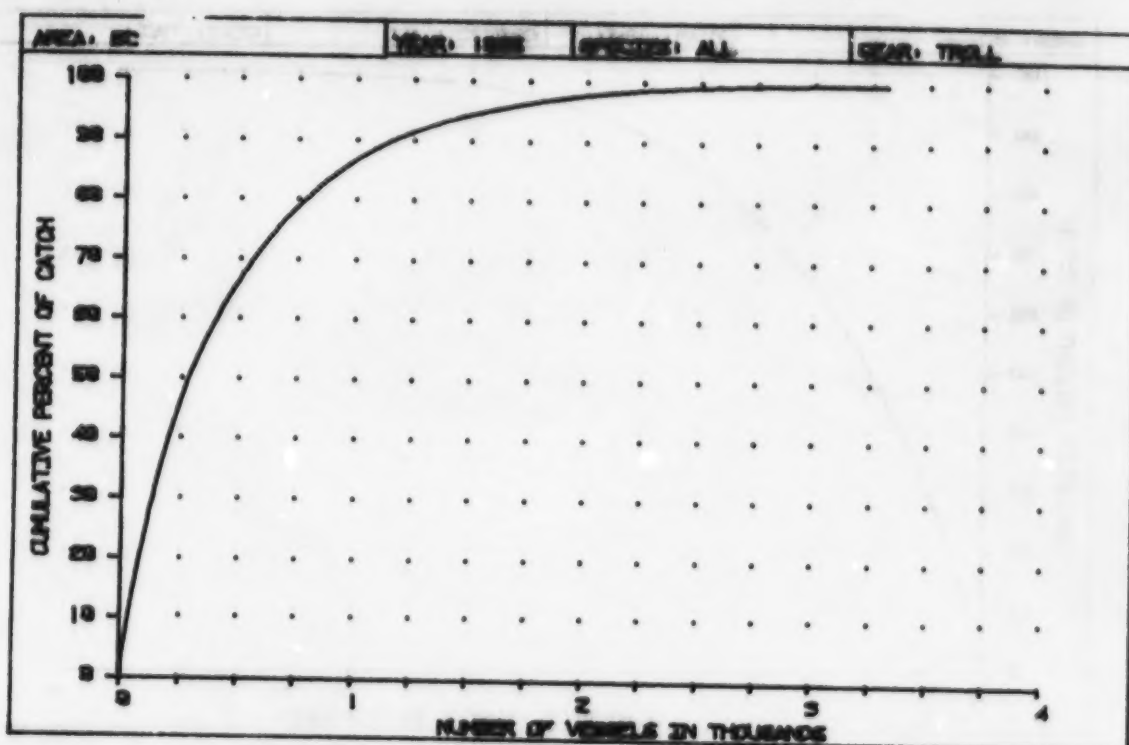


Figure C2. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1968.

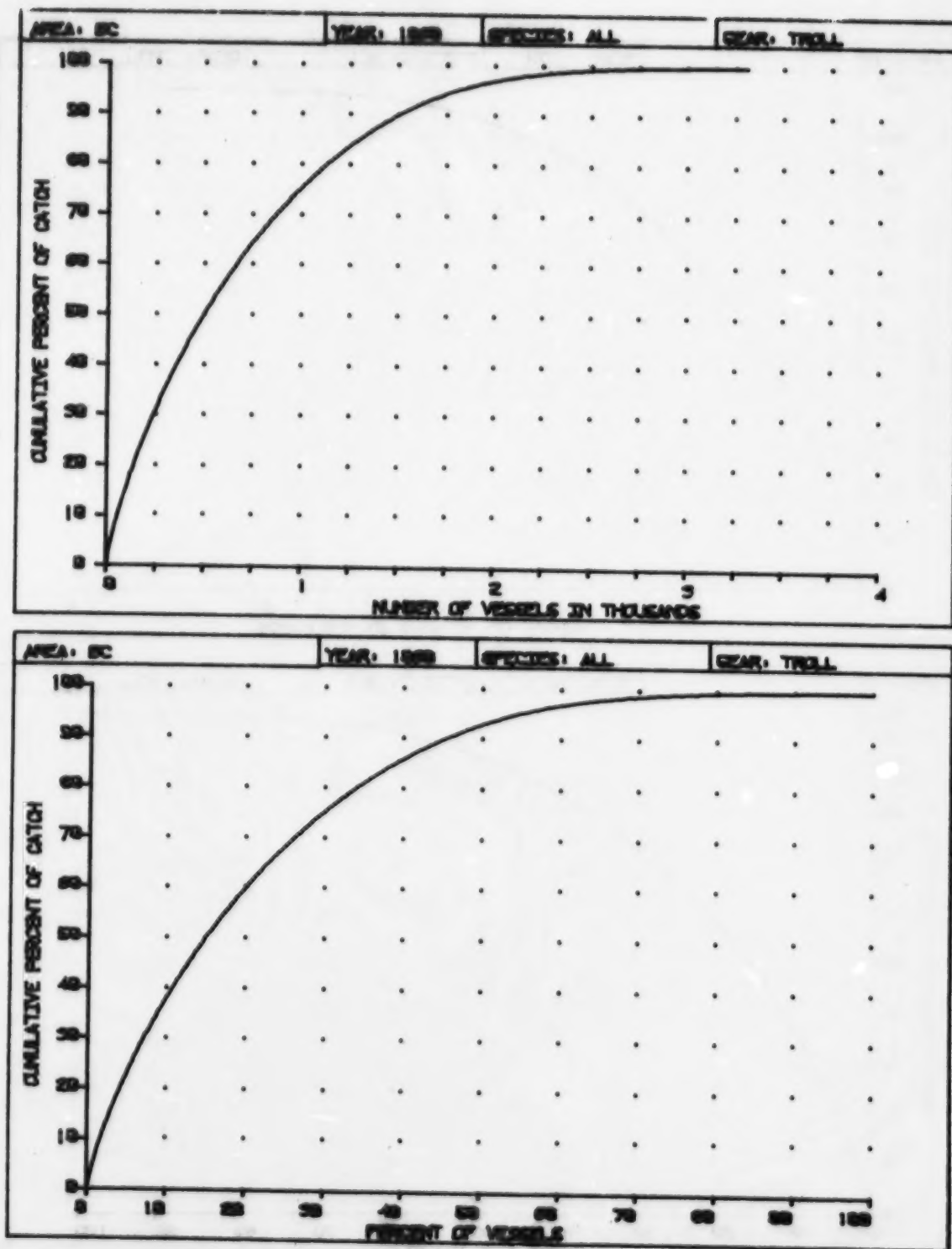


Figure C3. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1969.

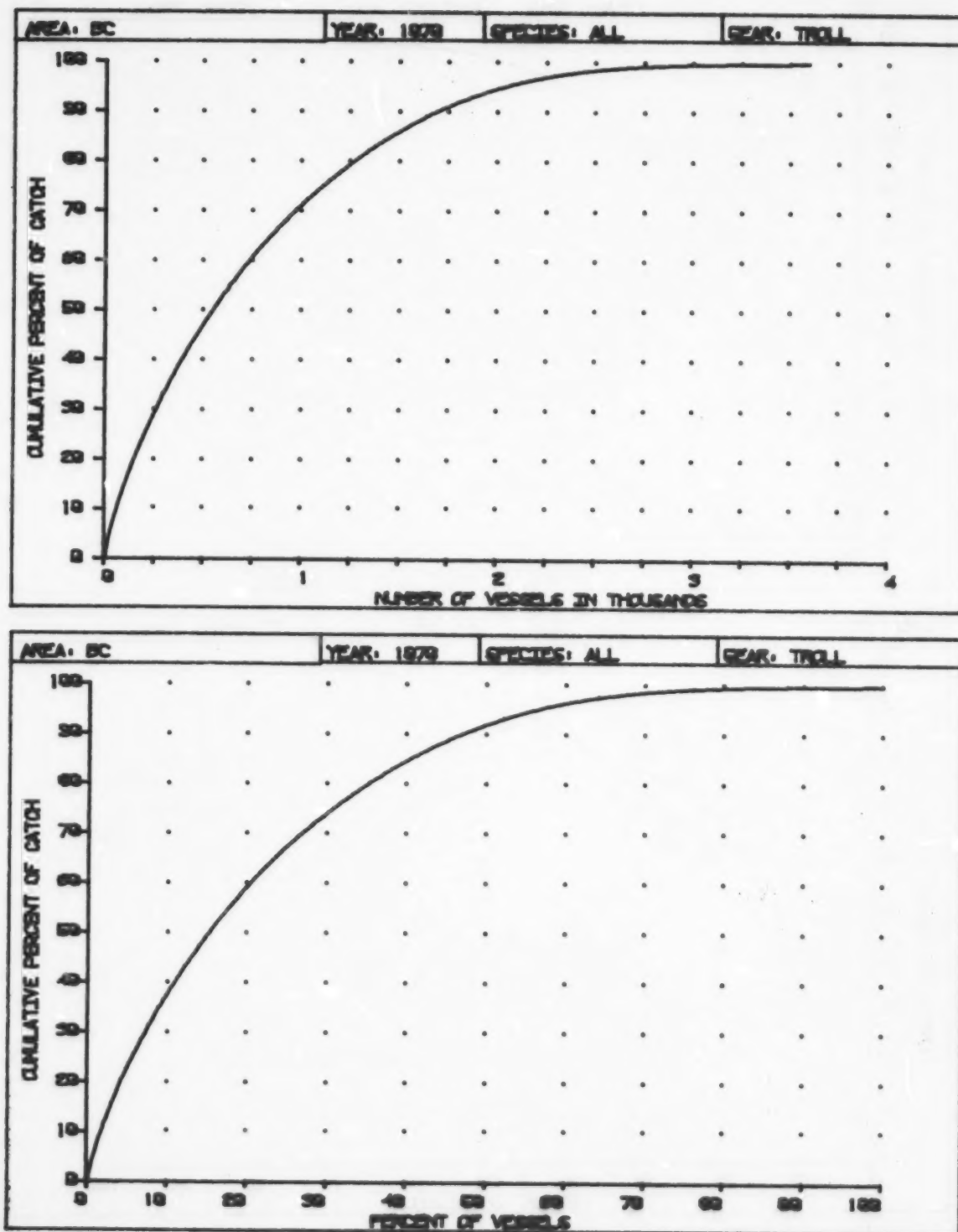


Figure C4. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1970.

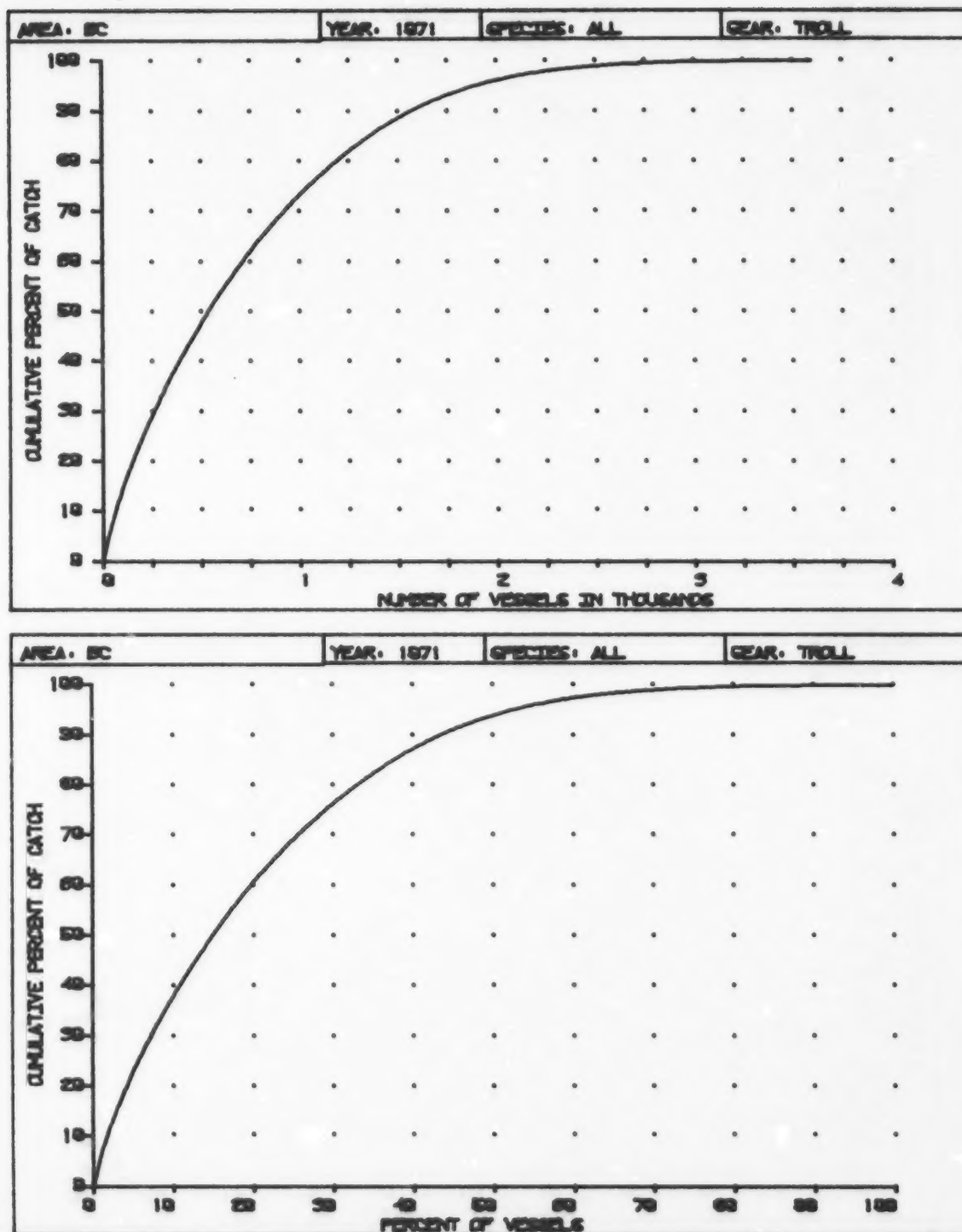


Figure C5. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1971.

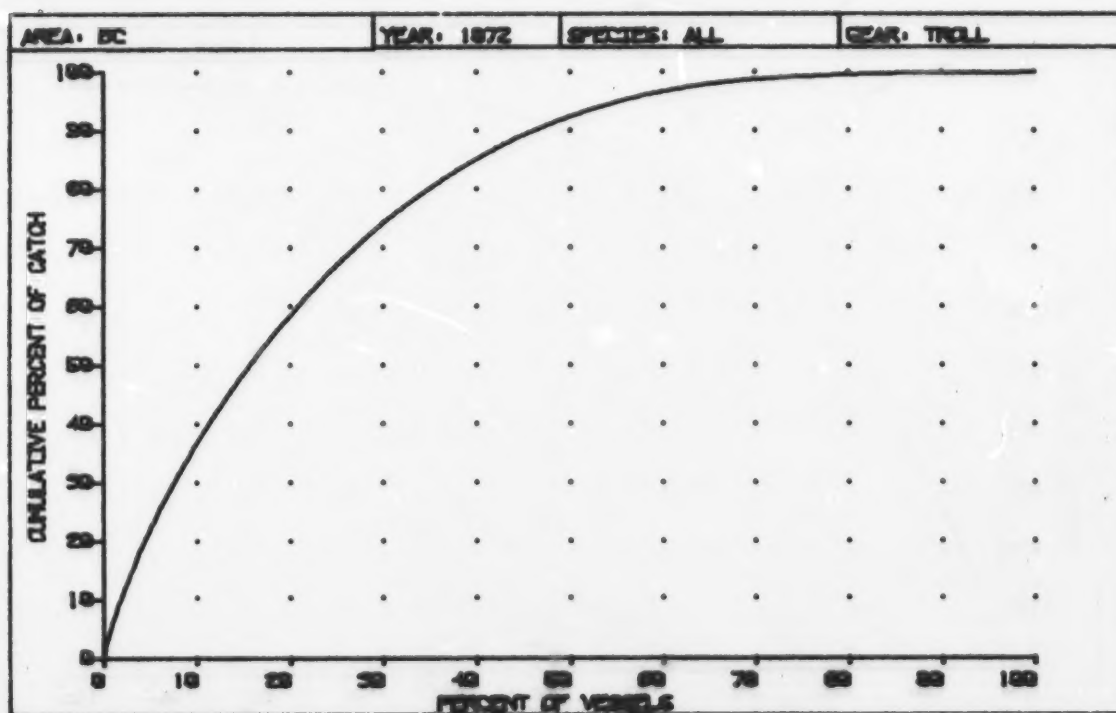
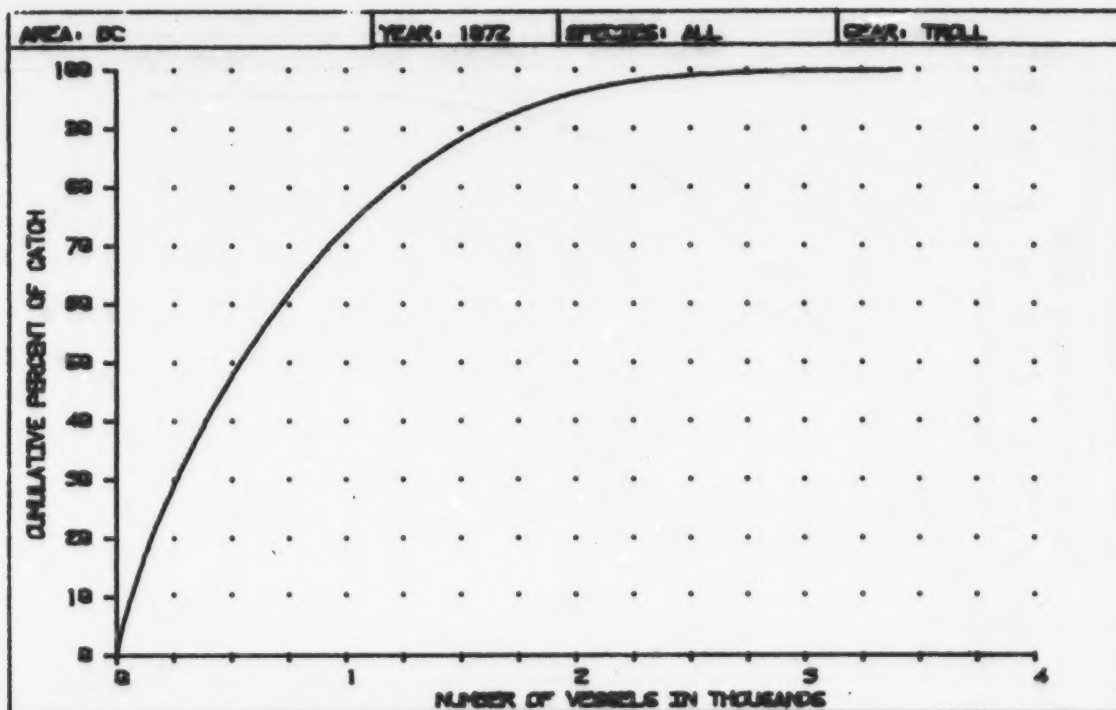


Figure C6. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1972.

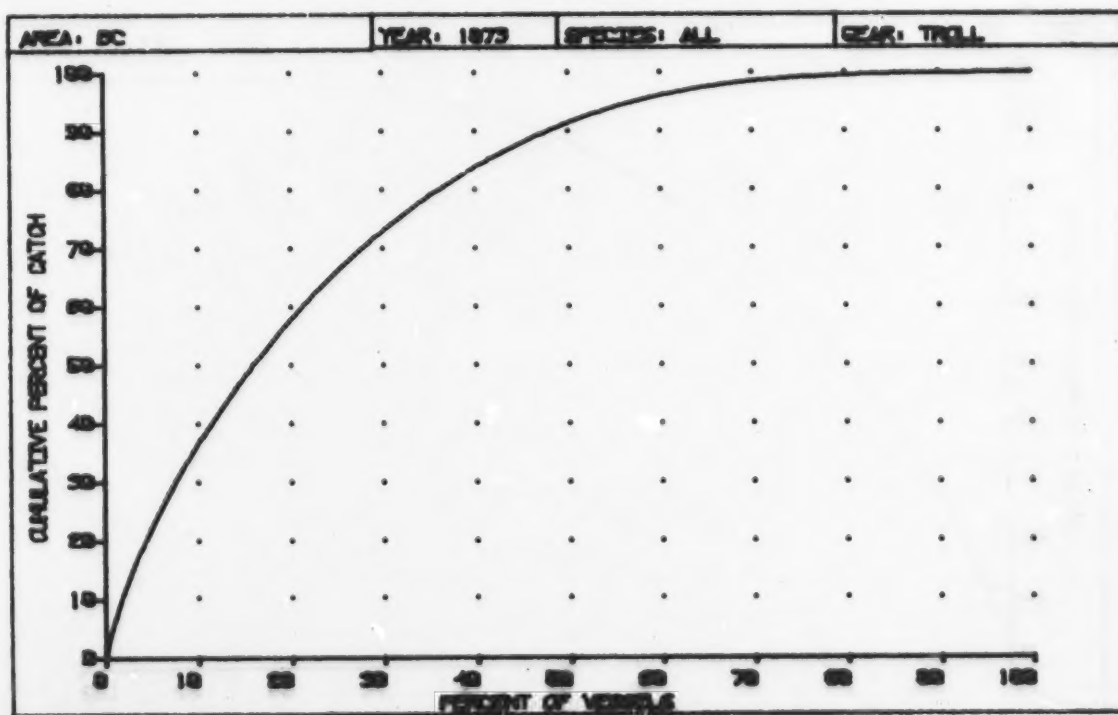
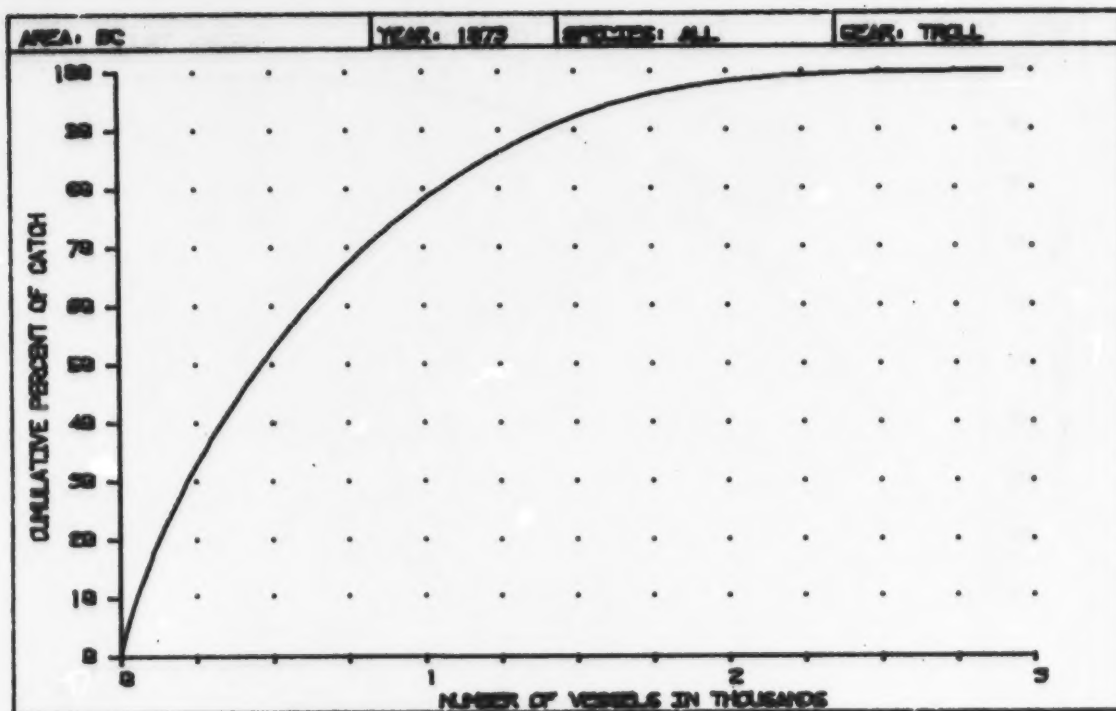


Figure C7. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1973.

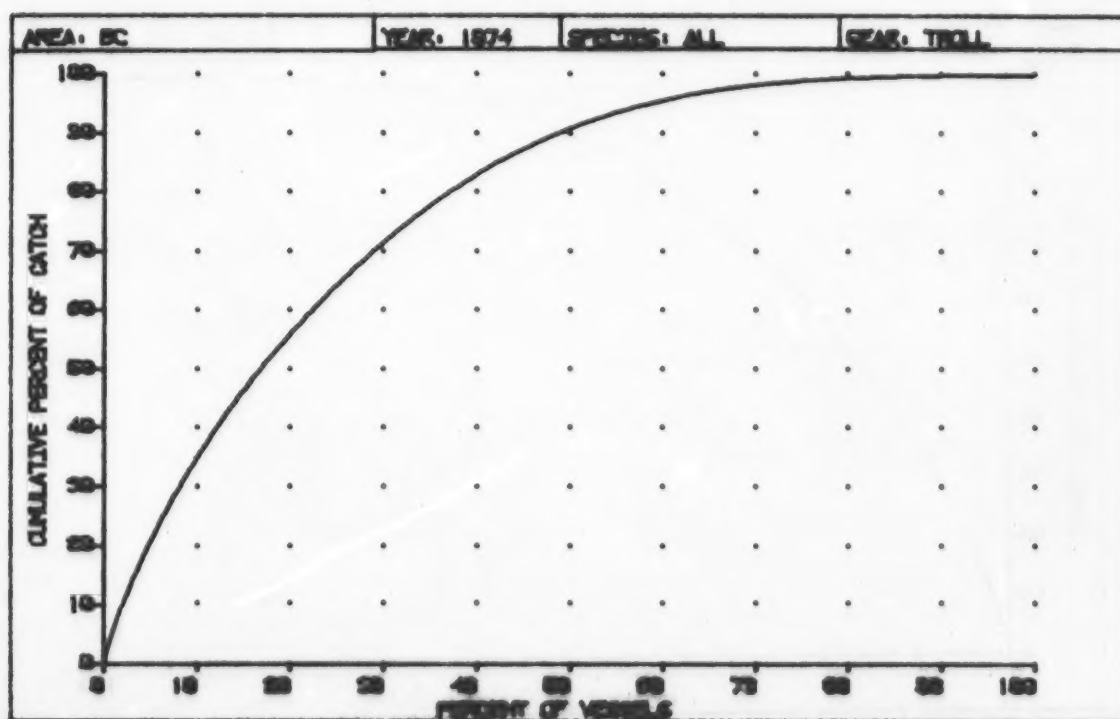
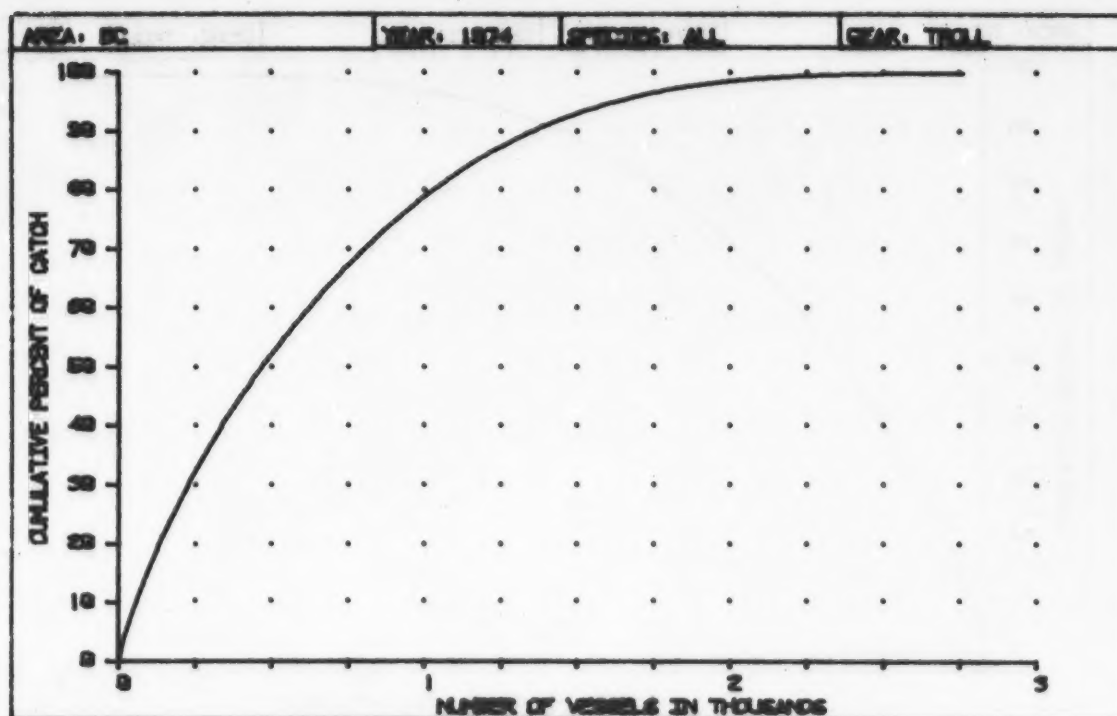


Figure C8. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1974.

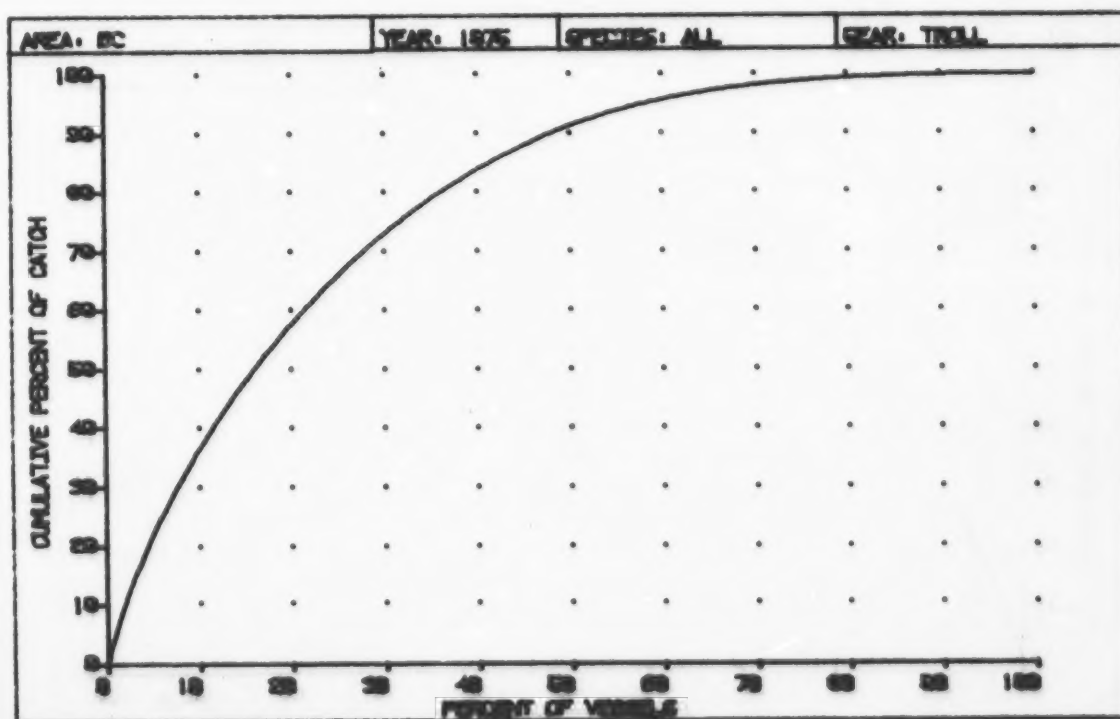
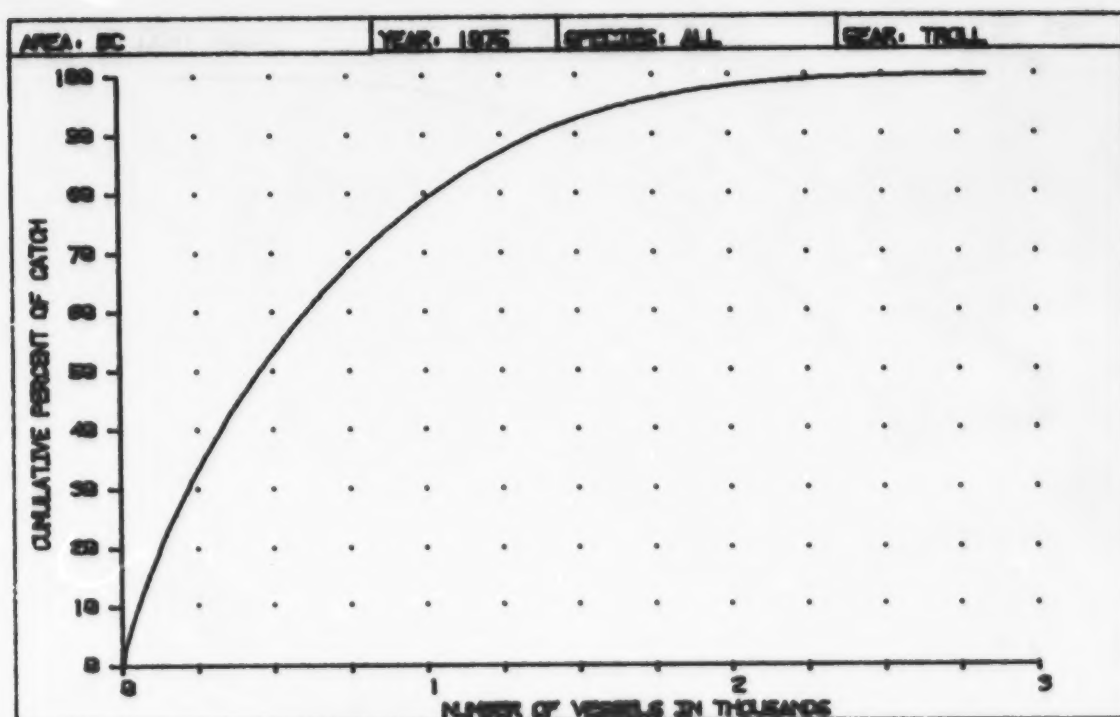


Figure C9. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1975.

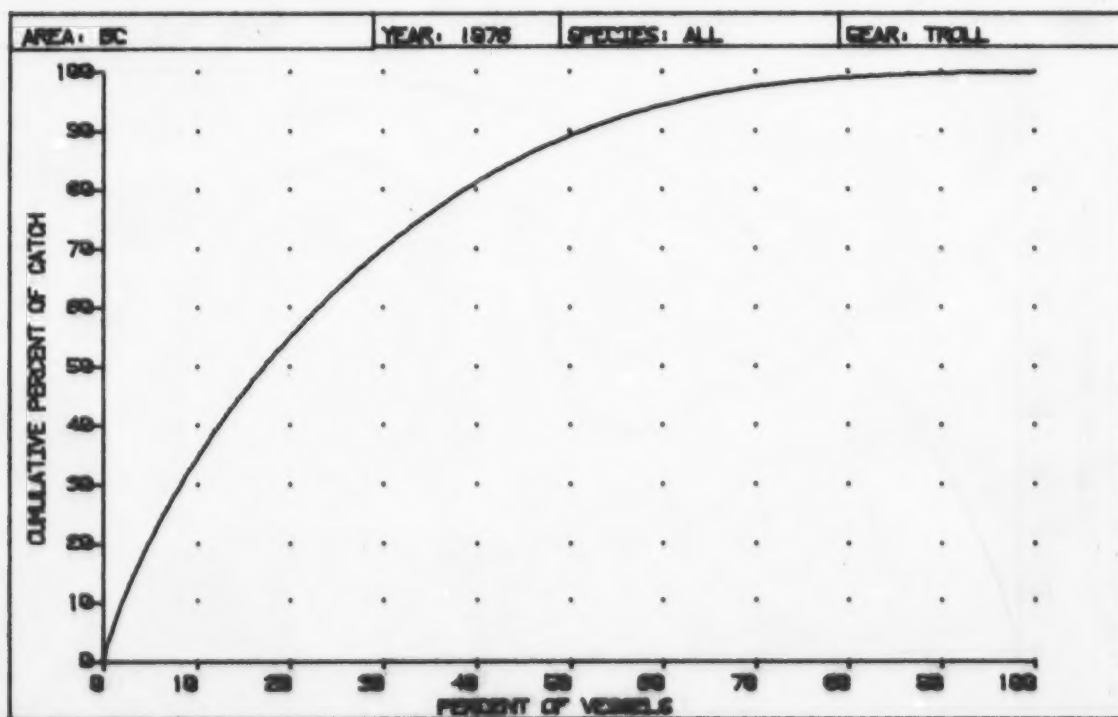
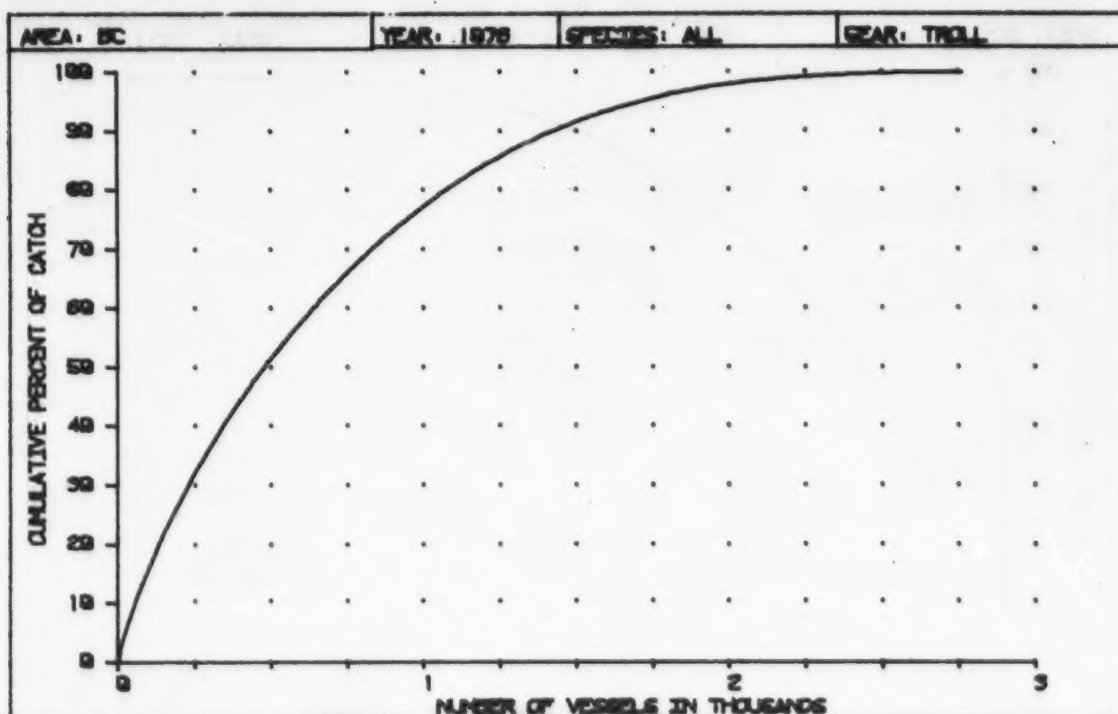


Figure C10. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1976.

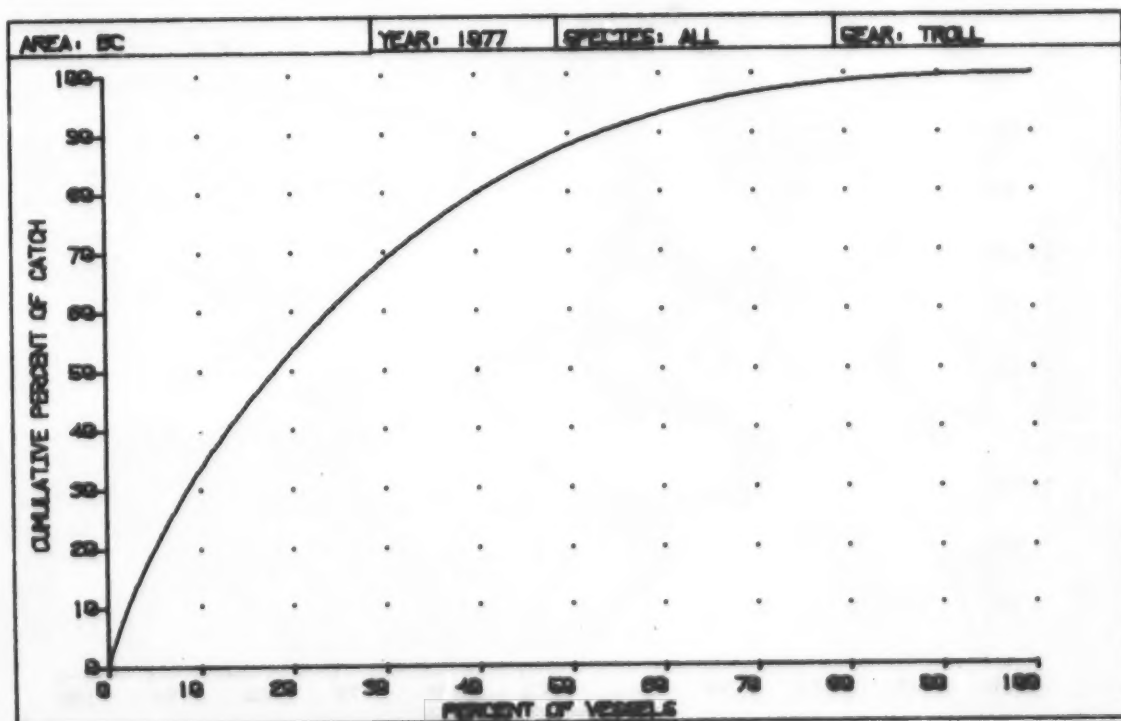
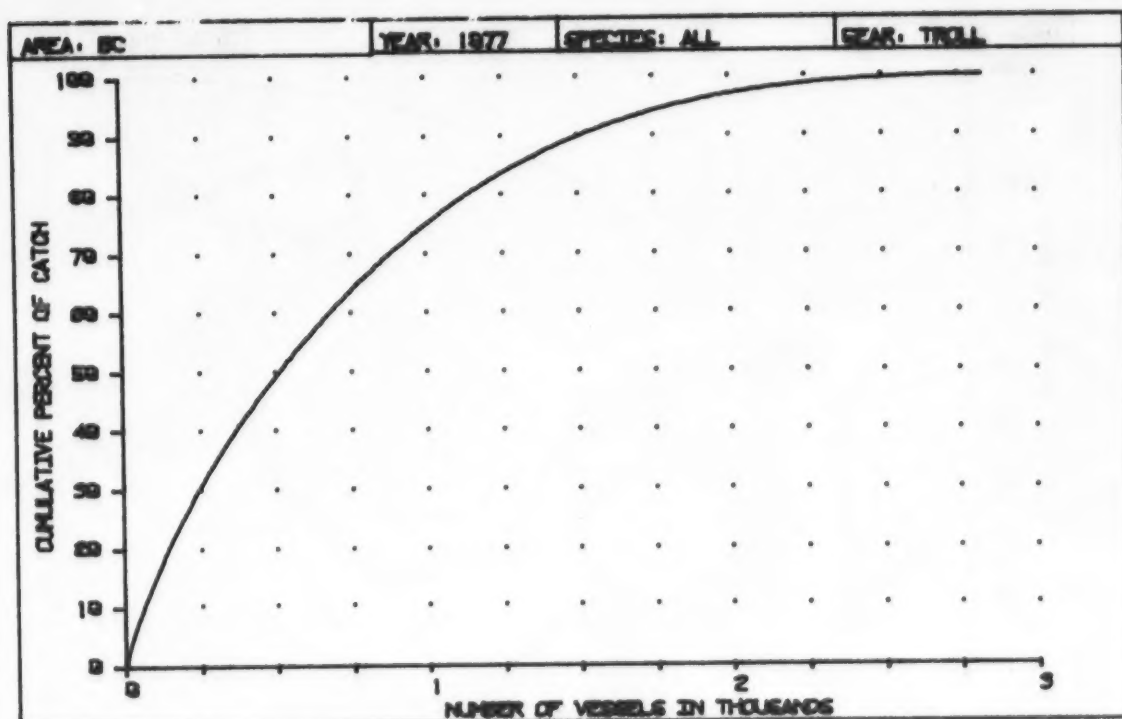


Figure C11. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1977.

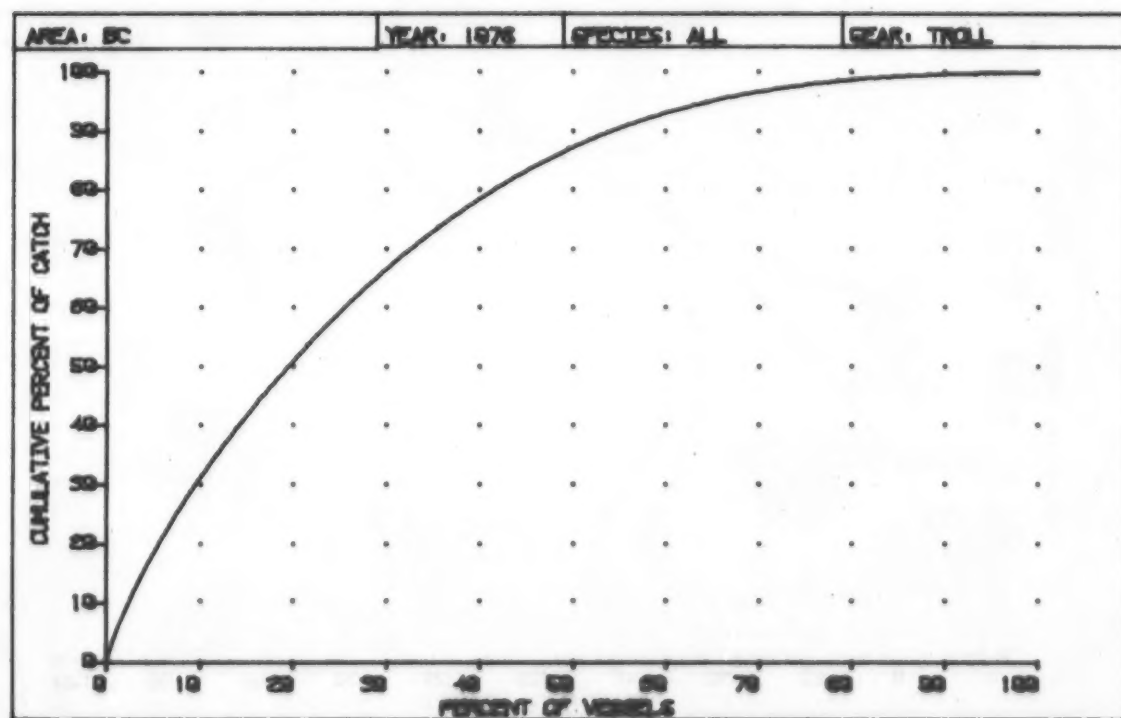
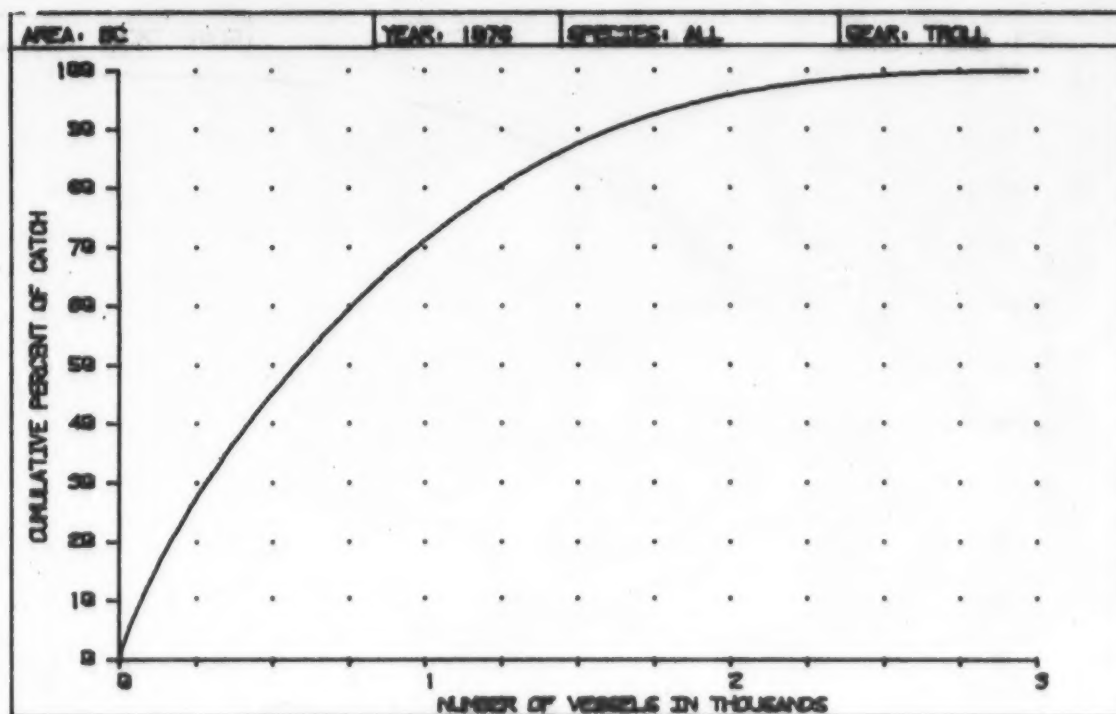


Figure C12. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1978.

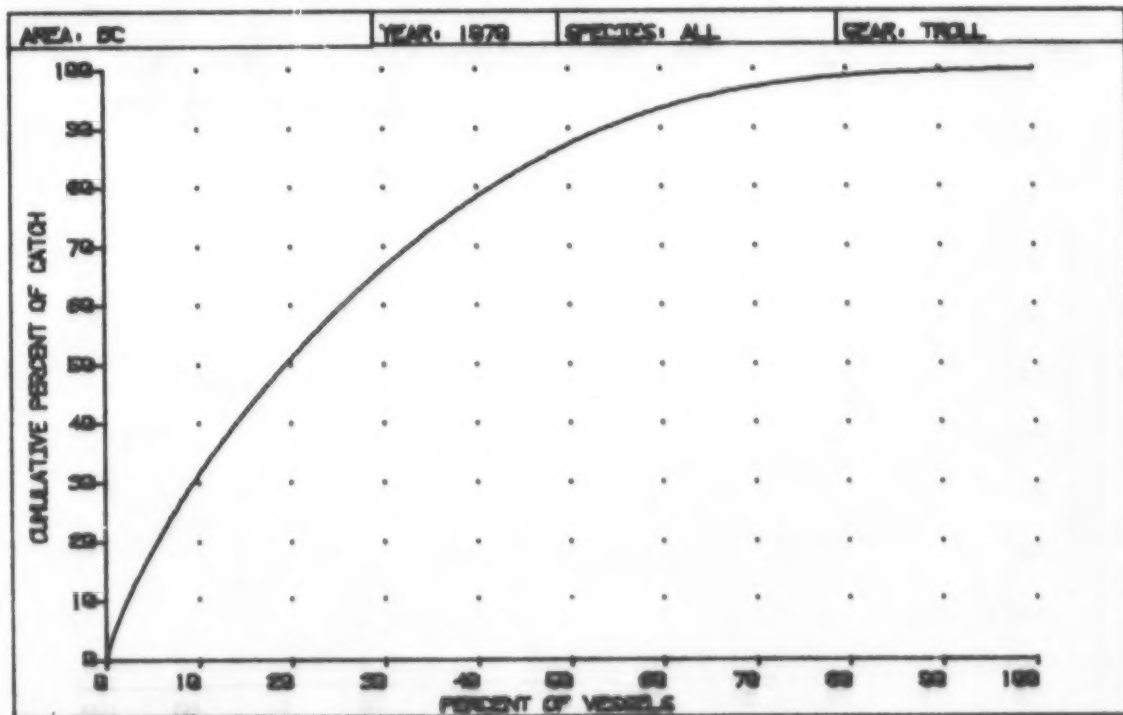
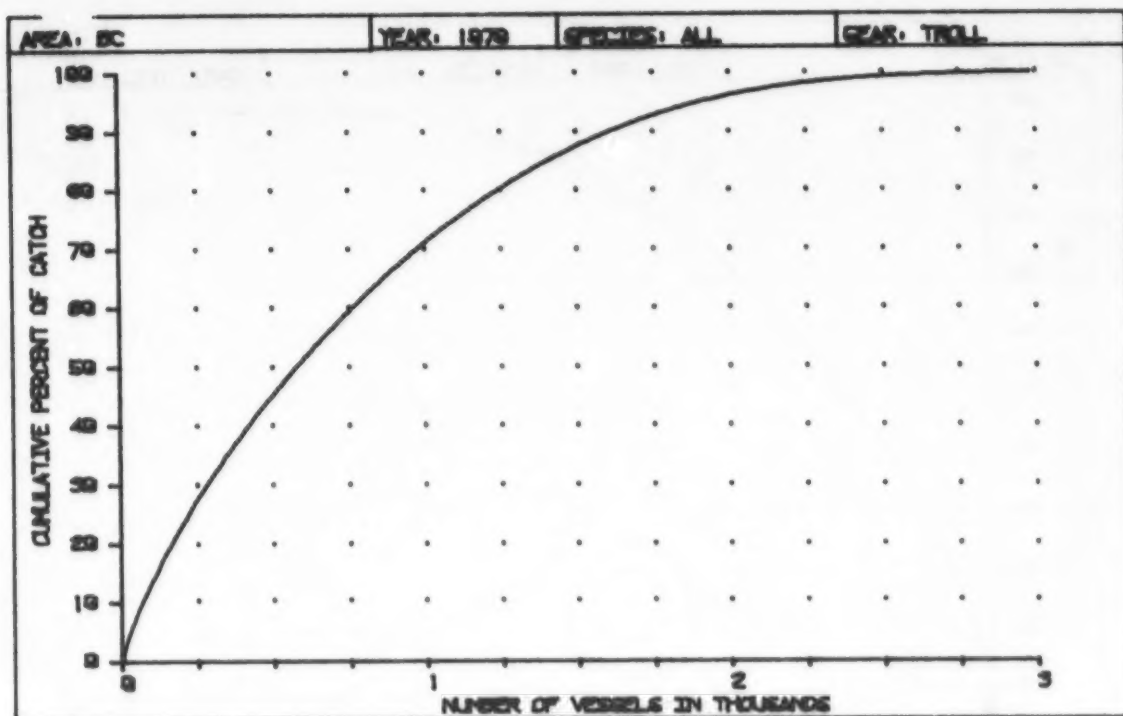


Figure C13. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1979.

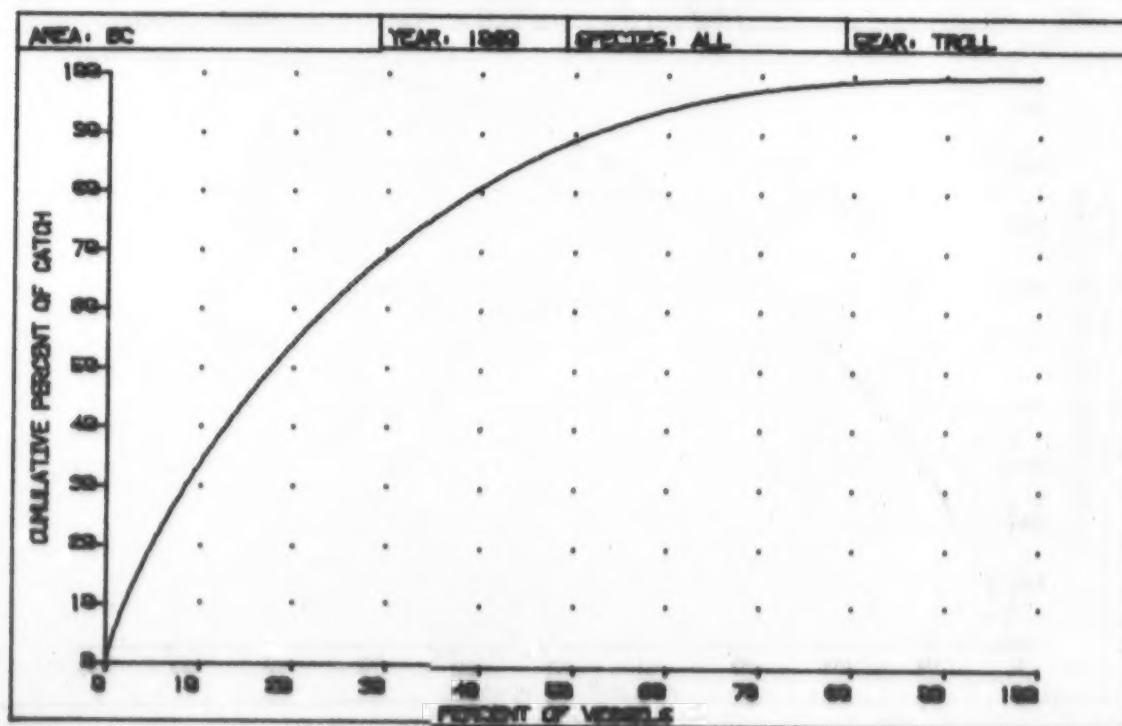
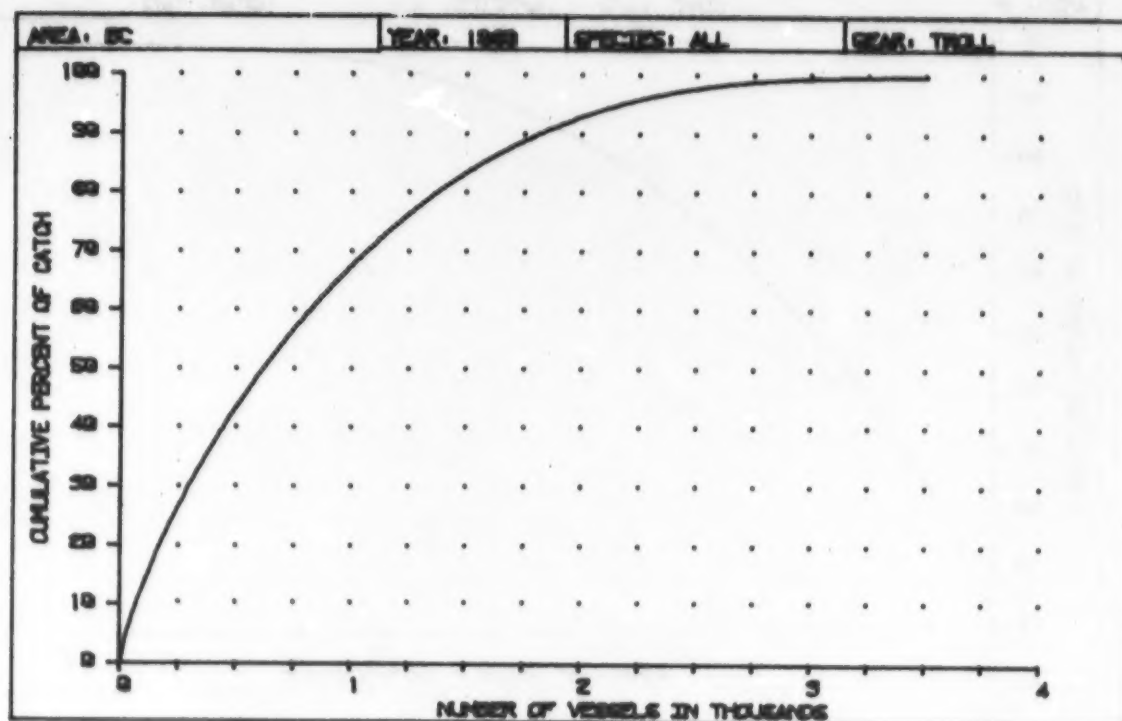


Figure C14. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1980.

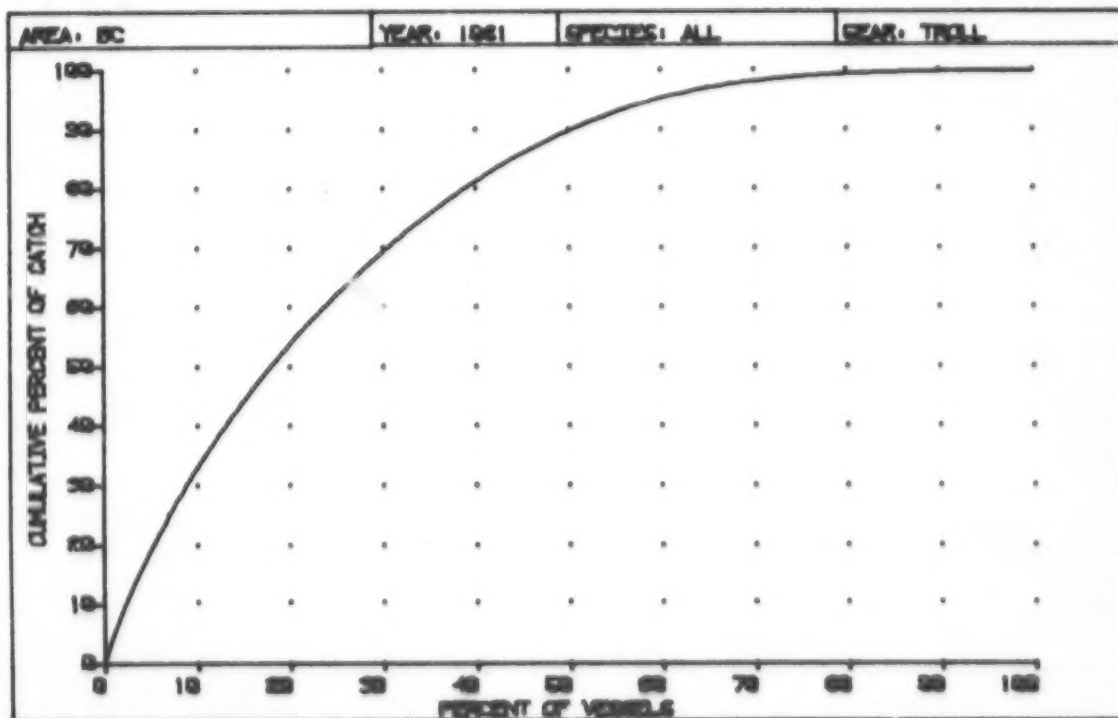
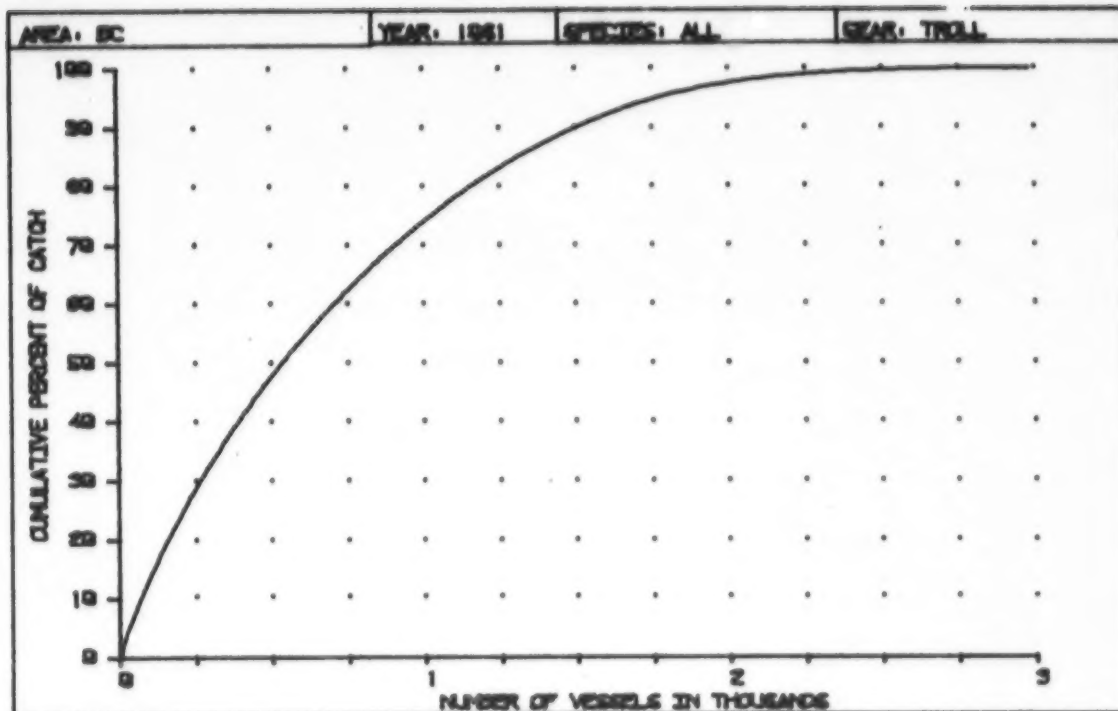


Figure C15. Cumulative percent of catch of Pacific salmon versus number and percent of vessels that used troll gear and participated in the fishery, 1981.